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The U.S. has been the world's leading superpower when it comes to capability and capacity since the end of WW II. History continues to show us that we will provide military forces in support of domestic, international conflicts and instability worldwide, now and in the future. With our capacity and capability we can do many things, especially provide drinkable water to our military forces, partners, and those we are tasked to help in support of the military and humanitarian operations we conduct. This thesis examines the U.S. military's increasing reliance on the use of bottled water in conducting these military operations. The U.S. military has been conducting operations across all spectrums of conflict throughout its history, and most recently in Iraq, Afghanistan, Haiti and support to Japan. In all of these operations, the U.S. military was heavily reliant on the use of bottled water to support our forces, as part of the tool to help win the hearts and minds of the people in the execution of our mission.

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NATIONAL DEFENSE UNIVERSITY

JOINT FORCES STAFF COLLEGE

JOINT ADVANCED WARFIGHTING SCHOOL

THE U.S. MILITARY'S RELIANCE ON BOTTLED WATER DURING MILITARY OPERATIONS

by

James S. Moore

Lieutenant Colonel (P), U.S. Army

THE U.S. MILITARY'S RELIANCE ON BOTTLED WATER

DURING MILITARY OPERATIONS

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James S. Moore

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A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

This paper is entirely my own work except as documented in footnotes. (or appropriate statement per the Academic Integrity Policy)

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ABSTRACT

The United States has been the world's leading superpower when it comes to capability and capacity since the end of World War II. History continues to show us that we will provide military forces in support of domestic, international conflicts and instability worldwide, now and in the future. With our capacity and capability we can do many things, especially provide drinkable water to our military forces, partners, and those we are tasked to help in support of the military and humanitarian operations we conduct. This thesis examines the U.S. military's increasing reliance on the use of bottled water in conducting these military operations. The U.S. military has been conducting operations across all spectrums of conflict throughout its history, and most recently in Iraq, Afghanistan, Haiti and support to Japan. In all of these operations, the U.S. military was heavily reliant on the use of bottled water to support our forces, as part of the tool to help win the hearts and minds of the people in the execution of our mission. The military has the capability to produce its own water once established in an area of operations, but bottled water has been the drink of choice by a majority of our forces and other personnel. Bottled water is not always economically effective and is very resource intensive, but some indications show that it may be a necessity in the early stages of the mission in a theater of operations, mainly because it is easy to procure and the choice of a majority of the military force.

This thesis begins with a review of the history, economic impact, and planning considerations when using bottled water in military operations. The paper will then offer a look at our water support capability and dependence upon bottled water through two elements of operational design, operational reach and arranging operations, while looking at our water support capability through the lens of Doctrine, Organization, Training, Materiel, Leadership,

Personnel, and Policy (DOTMLP-P). Lastly, this thesis will propose alternatives and considerations regarding this military problem.

DEDICATION

"My logisticians are a humorless lot…they know that if my campaign fails…they are the first ones I will slay!"

-- *Alexander the Great*

"There is nothing more common than to find considerations of supply affecting the strategic lines of a campaign and a war."

-- *Carl von Clausewitz*

"The line between disorder and order lies in logistics…"

-- *Sun Tzu*

"Logistics is the first battle… If you lose the logistics battle, then there aren't any more battles."

-- *General John G. Colburn, USA, 1999*

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INTRODUCTION

"As we select our forces and plan our operations …we must understand how logistics can impact on our concepts of operation….Commanders must base all their concepts of operations on what they know they can do logistically."
- Gen Alfred M. Gray Jr. USMC [1]

The U.S. military's reliance on bottled water in current military operations hinders our ability to apply key elements of Operational Design, and thus limits options in support of our mission within all phases of the campaign. The U.S. military will have to consider the operational, resource, and logistics impact of using bottled water as a primary means of support for every operation that is conducted. U.S. military forces will begin to lose their capability, knowledge, and skill to purify water in support of operational requirements across the wide range of military contingencies, if our forces continue to rely upon bottled water. For every military operation that requires use of bottled water, there are some other alternatives to provide water support. This paper will have relevance to any Commander or logistical planner analyzing ways to support operational forces during Phase 0 through Phase III, and the transition to Phase IV and Phase V of an operation. It will analyze the resources and costs that are involved, and offer insight as to why we choose bottled water as a first option above all others, and why it may be hindering our overall water purification capability, as well as our flexibility in applying elements of operational design. The existing body of knowledge on this topic looks at lessons learned from past and current military operations, and gives some statistical information; however there

[1] Chairman Joint Chiefs of Staff, *Joint Concept for Logistics* (Washington, DC: Department of Defense, 2010), 1. Hereafter cited as Joint Concept for Logistics.

is nothing that looks at the impact of the logistics of water from a holistic standpoint. This thesis will attempt to capture the entire essence of the problem, exploring why current Joint Force Commanders (JFC) and logistics planners approach the problem with an automatic bottled water solution. Most significantly, this paper will examine how our reliance on bottled water impacts our flexible use of elements of operational design.

Providing water to U.S. forces and civilian personnel in a theater of operations requires a great deal of force structure and logistics capability. Water requirements vary widely in a theater of operations, whether it is combat or humanitarian assistance/disaster relief (HA/DR). Water is needed to support every area of the military effort, to include force hydration, feeding and hygiene, construction, vehicle maintenance, weapon system maintenance, aircraft, medical requirements, and other support.

This paper will analyze lessons we have learned in providing bottled water over the past and present conflicts involving the U.S. military in a theater of operations. We will look at how the military has steadily increased its reliance on bottled water; despite the cost, resource intensiveness, and our capability to produce water by other methods. In addition, we will examine other options our military planners and leaders have for supporting U.S. forces with water.

Again, this discussion is relevant to any Joint Force Commander or logistical planner, whose job is to best support their operational forces during the force reception, staging, onward movement, and integration (RSOI) stage, build-upstage, combat operations, and transition phases to stability and support operations. The amount of resources and costs that are involved in supporting a large military and civilian force with bottled water during combat operations and humanitarian assistance/disaster relief (HA/DR) operations is very robust. The U.S. military

must understand why our forces want to choose bottled water as a first option. We have to understand why commanders and planners approach the problem the way they do, with a bottled water solution. Our existing body of knowledge on this topic offers a look at some lessons learned from past and current military operations, giving both anecdotal and statistical information.

How does the large use of bottled water impact the Joint Force Commander (JFC) and his military campaign? The source of water has tremendous impact on two key elements of operational design. The first is Operational Reach and the second is Arranging Operations. As defined by Joint Publication 5-0, Operational Reach is defined as "the distance and duration across which a unit can successfully employ military capabilities." A JFC's operational reach being constrained or limited by geography within an area of operations, or it can "be extended through forward positioning of capabilities and resources, increasing the range and effects of weapon systems, leveraging host nation support (HNS) and theater contracting support, and maximizing the throughput efficiency of the distribution architecture." The relation of operational reach to bottled water is one that enables the JFC to enhance his logistics support capability while minimizing his resource requirements in order to conduct the mission. A JFC, that can expand his water support capability with reduced costs, reduced lift requirements, fewer force protection assets, providing water from the closest source, and better distribution administratively or tactically to the receiving unit or personnel, will have a synchronized and well orchestrated logistics structure. Over reliance on bottled water will impact the JFC's operational reach capability.[2]

[2] Chairman of the Joint Chiefs of Staff, *Joint Pub 5-0, Joint Operation Planning (Revision Final Coordination)* (Washington, DC: Department of Defense, 2010), III-37 - III-38. Hereafter cited as JP 5-0, Joint Operational Planning.

The other element of operational design that is affected by the logistics capability to provide water is Arranging Operations. Arranging Operations is explained as,

> A combination of simultaneous and sequential operations to achieve full-spectrum superiority and the end state conditions with the least cost in personnel and other resources. Commanders consider a variety of factors when determining this arrangement including geography of the operational area, available strategic lift, and changes in command structure, force protection, distribution and sustainment capabilities, adversary reinforcement capabilities, and public opinion. Thinking about the best arrangement helps determine the tempo of activities in time, space, and purpose.[3]

As a key resource for achieving full-spectrum superiority, the water source and its relationship to arranging operations has impact on what type and amount of force structure the JFC plans and deploys to conduct the mission. It will have impact on how soon a JFC can get logistics units with the proper capability to manage, supply, purify, transport, and protect the water sources needed to support the operation. This is a tremendous consideration especially when looking at what forces go into the Time Phased Force Deployment Data (TPFDD). The proper synchronization and deployment of capabilities in the right arrangement will provide the optimal capabilities for the JFC when focusing on his mission set.[4]

From a theoretical standpoint, bottled water can be reviewed as one of the critical factors discussed in Dr. Joseph L. Strange's Theory of Center of Gravity (COG) Analysis. The primary factors are critical capabilities (CC), critical requirements (CR), and critical vulnerabilities (CV).

> Critical capabilities are those that are considered crucial enablers for a COG to function as such, and are essential to the accomplishment of the adversary's assumed objective(s). Critical requirements are the conditions, cost, resources, and means that enable a critical capability to become fully operational. Critical vulnerabilities are those aspects or components of critical requirements that are deficient, or vulnerable to direct or indirect attack in a manner achieving decisive

[3] Ibid.
[4] Ibid., III-40 – III-43.

or significant results. Collectively, the terms above are referred to as critical factors.[5]

Bottled water is considered primarily a critical vulnerability for the JFC. Depending on the mission, it may also be a critical capability. Water must be protected and preserved in order for a commander to effectively conduct the mission. Just as a "JFC must possess operational reach and combat power to take advantage of an adversary's critical vulnerabilities, he must also protect friendly critical capabilities within the operational reach of an adversary."[6]

It has been estimated that the total cost of supplying bottled water from the U.S. to a theater of operations can cost approximately $5.00 per gallon.[7] This amount is similar to another critical, but expensive commodity that we are dependent on to use as a force - fuel. Bottled water is not the most sustainable option, but indications are that it is a necessity during certain phases of a theater campaign plan. Based on the research that was conducted, it seems that military forces are reluctant to drink anything other than bottled water. They are hesitant when it comes to drinking water from Reverse Osmosis Water Purification Units (ROWPU), due to its perceived heavy chlorination, and host nation sources of water generally do not pass the strict military standards and guidelines in water testing. Water that does not pass inspection standards will not be issued to U.S. forces, nor will it be used for cooking or hygiene. Water support may come from the U.S., or a country within the area of influence, and sometimes the host country. Bottling water in a theater of operations eliminates an upfront logistics demand. It allows for a reduction in force protection requirements and resource expenditures, which compensates itself by overall decreased costs in supplying water and in reducing logistics support structure, thus

[5] Dr. Joseph L. Strange and COL Richard Iron, *Understanding Centers of Gravity and Critical Vulnerabilities, Part 2:The CG-CC-CR-CV Construct:A Useful Tool to Understand and Analyze the Relationship between Centers of Gravity and their Critical Vulnerabilities* (Virginia: USMC War College), 7.

[6] JP 5-0, Joint Operational Planning, III-23 - III-26.

[7] Lee O. Wyatt, Lieutenant Colonel, USAF, *Water...Bulk or Bottled?, It's a Bigger Issue Than That.* (Maxwell Air Force Base, Alabama: Air University, 2002), 7.

contributing to a smaller logistics tail. Nonetheless, in-theater bottling is not always the panacea. Use of some surface water presents safety risks and using local resources can also create local shortages. Each of these will be discussed later in the paper.

Commercially bottled water has become the primary source of drinking water for our military forces, especially in conflicts where forces are located away from their Forward Operating Bases (FOB). For example during the beginning stages of Operation Iraqi Freedom (OIF), bottled water unexpectedly became the norm for the entire operation, consuming more distribution capacity than was originally planned. This appears to be due to (1) aesthetics - soldiers liked the taste of bottled water better than ROWPU produced water, and the clear plastic bottle implied purity, and (2) convenience - bottled water is easily carried and stored in vehicles. For example, the Army Food Advisor at the Army Center of Excellence, Subsistence, said, "…bottled water is ingrained in our culture - leaders expect it and will continue to get it."[8] Another example was expressed by the U.S. Army Center for Health Promotion and Preventive Medicine, which stated in a March 24, 2003 information paper, "…that the use of bottled water in deployments has increased dramatically during the last decade due to its rapid availability, its logistical flexibility, and its immediate acceptability by the deployed force…."[9]

Even in today's humanitarian assistance environment, our first mode of support is to provide bottled water along with food and other items. In austere conditions as the support operations conducted by the military during the Haiti Earthquake Relief Operations of 2010, the U.S. military was there providing bottled water as an initial support requirement. Initial entry into Haiti required the military to provide what was easily available to get the forces and people working smoothly, since no other support structure was in place. Bottled water was the easiest

[8] Department of Defense Inspector General, *DODIG Report RC Bottled Water Report* (Washington, DC: Department of Defense, 2005), 11. Hereafter cited as DODIG Report RC Bottled Water Report.

[9] Ibid.

solution during the onset of this operation, but as the support and structure gets more stable, the military must consider switching to a bulk water solution. At times, military personnel confuse the terms bulk water and packaged water. In official military terms, water is referred to as bulk (ROWPU) or packaged (bottled water) only.[10] Despite the challenge of being able to distribute water and supplies throughout Haiti, force protection and security was another major concern, not only for the military force, but also for the people being supported. Military forces must ensure that the water would not be hoarded or stolen from people who really needed the assistance.[11] Additionally, one of the largest drawbacks to bottled water is the waste stream it creates and must be managed. For example, plastic bottles were one of the most costly components of the solid waste streams generated in the Balkans, where there was an abundant supply of potable water.

The U.S. military's reliance on bottled water in current military operations hinders our ability to apply some elements of Operational Design, and thus limits options in support of our mission within all phases of the campaign. Acknowledging that Dr. Strange's construct includes the relationship of these factors to the Center of Gravity, this study is not intended to discuss or consider whether water could be considered a center of gravity. At the same time, I trust the reader will implicitly accept the absolute necessity of water in the conduct of warfare, and recognize its criticality to the success of any military operation. In this vein, the U.S. military should consider the operational, economic, and logistics impact of using bottled water as a primary means of support for every operation that is conducted. Further, the JFC should consider viable alternatives for sourcing water in any operation.

[10] DODIG Report RC Bottled Water Report, 10.

[11] Jim Michaels and Marisol Bello, "US Airdrops Food and Water, Bottlenecks at all ports force workarounds," *USA Today*, January 19, 2010, 1.

CHAPTER 1
WATER SUPPORT TO MILITARY OPERATIONS

History

"Magically appearing from inside the earth, spring water has always had a powerful mystique. Civilizations have fought over such resources."
- Elizabeth Royte [1]

As we look back through history, we may ask ourselves "what generated the requirement to supply water in military operations?" Why has water purification capability played such a critical role in military campaigns or operations? When did the military feel as though bottled water was an alternative source to be used in support of military operations? These are all questions that play a role in understanding our reliance upon bottled water.

Throughout history, during many great conflicts and battles, armies have suffered from water shortages and contaminated water supplies. "Even the greatest of the Great Captains have had their plans upended for lack of water or have fallen victim to the ravages of waterborne illness."[2] This challenge with water is a major reason why great leaders have had their campaign plans disrupted because of waterborne illnesses as described in the following quote:

> The use of water as a military tool and combat weapon has been going on as early as 1187. Major impacts have resulted from contaminated water such as typhus, dysentery, and diarrhea, all of which have led to the demise of countless soldiers throughout history, including poisoning of drinking water to the flooding of rivers and levies, water has been a combat weapon for military forces throughout the years.[3]

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[1] Elizabeth Royte, *Bottlemania, How Water Went on Sale and Why We Bought It.* (New York: Bloomsbury USA, 2008), 3.

[2] Pacific Institute for Studies in Development, Environment, and Security, "Water Conflict Chronology," The Pacific Institute, http://www.worldwater.org/conflict.htm (accessed November 2010).

[3] Ibid.

Some examples of how water support has developed over time are listed below. The list shows periods of time when forces, services, or commanders had to overcome challenges relating to water in support of their forces and other military operations:

- 325 BC - Alexander the Great lost an estimated three-quarters of his entire Macedonian Army when its water supply ran out. They were devastated by the Gedrosian desert, in southern Pakistan. Due to the lack of water, he lost more soldiers than in all of his previous campaigns combined.
- 1096 AD - The Turks defeated the so-called People's Crusade, as they ran out of water and had to surrender. Their supply lines were cut and they were forced to drink the blood of donkeys and their own urine to survive.
- 1346 AD – Battle of Crecy – Knights and archers from King Edward's army were afflicted with dysentery. "...the French scoffingly referred to them as the 'bare-bottomed' army."[4]
- 1812 – Napoleon lost thousands of his forces to water-borne typhus and dysentery during the ill-fated Russian campaign.
- 1876 – During, George Armstrong Custer's last stand at Little Big Horn, elements of the 7th Cavalry was isolated in nearby hills. These elements, particularly the wounded, were suffering from lack of water. They were rescued by 16 soldiers who volunteered to serve as water carriers (all of whom were subsequently awarded Medals of Honor).[5]
- 1917 – British General Edmund Allenby had to find ways to support his forces with water during his World War I campaign in Palestine.
- 1939 – 1945 – U.S. Army Corps of Engineers were responsible for the water supply mission. The 518th Engineer Water Supply Company located water sources, tested and purified water, and supervised distribution to the troops. The other armed forces and services usually provided their own trucks to haul water from Engineer water points. In North Africa, for example, the Engineer Company "found multiple water points and - using a series of pumps, chemical disinfectants and 3,000-gallon collapsible canvas tanks for temporary storage - played a critical role during the Allied drive through Tunisia. On its peak day, the 518th distributed 72,840 gallons of water."[6]
- 1942 - Field Marshall Erwin Johannes Eugen Rommel's World War II Afrika Corps advance was suspended along the El Alamein Line. This was due to lack of supplies, exhaustion of his forces, and severe shortage of water.
- 1967 – Arab – Israeli War, many Egyptian soldiers were cut off from their units and had to walk about 200 kilometers through the hot sand by foot before reaching the Suez Canal, all with limited supplies of food and water while being exposed to intense heat. Thousands of Soldiers died as a result. Many Egyptian

[4] Ibid.

[5] Dr. Steven E. Anders, "Liquid Logistics: A Brief History of the Petroleum and Water Missions," *Quartermaster Professional Bulletin*, PB 10-02-1 (Spring 2002): 9-10.

[6] Ibid.

Soldiers chose instead to surrender to the Israelis. The Israeli soldiers were trained to drink a liter of water per hour, which made their fighting force competitively better prepared for this battle.[7]

- 1979 - The seizure of the American Embassy in Iran and the Soviet occupation of Afghanistan occurred. The U.S. military in response, organized the Rapid Deployment Joint Task Force (RDJTF), and a tanker carrying 9 million gallons of water was prepositioned in anticipation of contingency operations.[8]
- 1981 - During the Soviet Union fight against Afghanistan, the entire 5th Motorized Rifle Division was deemed combat ineffective due to hepatitis. Hepatitis was spread due to poor hygiene and lack of clean drinking water.[9]
- 1985 – New doctrine, units, and equipment were successfully tested by the Army in Egypt during Exercise Bright Star 85. Bright Star was a multi-national exercise designed to strengthen military-to-military relationships and improve readiness and interoperability between U.S., Egyptian and Coalition forces. The U.S. used this venue to practice its doctrinal support requirements of providing food, fuel and water to ground forces in support of this training.
- 1990 – During Operation Desert Shield/Storm, U.S. Army Quartermaster water supply units deployed to support U.S. forces involved in the operation. The units deployed with Reverse Osmosis Water Purification Units (ROWPUs) and collapsible water storage tanks and drums. "…they ensured that no Allied troops lacked adequate supplies of fresh water."[10]

  Present – military forces continue to provide humanitarian assistance, disaster relief support and water purification to other military forces and civilian personnel as required by mission.[11]

[7] Ibid., 10.

[8] Wyatt, 3.

[9] Lester W. Grau, Lieutenant Colonel and William A. Jorgensen, Major, "Beaten by the Bugs: The Soviet-Afghan War Experience," *Military Review* VOLUME LXXVII (November-December 1997): 2.

[10] Anders, 9-10.

[11] Ibid.

Photo above: "Water-Cart showing the manner in which it is filled by pumps on the rear end. Tank held 150 gal., filled in 20 min, Marbache, (Meurthe-et-Moselle), France, 8 September 1918."[12]

[12] US Army Quartermaster Foundation, "Army Quartermaster Petroleum and Water History." Quartermaster Foundation, http://www.qmfound.com/army_petroleum_and_water_history.htm (accessed November 15, 2010).

Photo above: "Non-Commissioned Officer (NCO) from the 4th Quartermaster Company Water Section, Germany 1951."[13]

[13] Ibid.

Photo above: "Desert Shield-1990, Water Purification NCO checking P^H balance of stored water."[14]

[14] Ibid.

Water is an issue that has been at the forefront in times of conflict and combat, and is not a new challenge to the military or government. In 1953, the U.S. government approved and built a dam in Afghanistan to promote U.S. economic aid to the Helmand Province. This dam is over 320 feet high and 887 feet wide. This initiative was named the Kajaki project. The name Kajaki comes from a town located in the Helmand Province area. This project helped flow water to the area and establish hydro-electric power to the region. This was a tremendous initiative to support economic expansion in the region. The water brought great relief to the farm land and people living in the region. This allowed personnel to economically prosper and support their families and their livelihood.[15]

This is a clear example of the U.S. government providing humanitarian assistance for water support to a region in the early 1950's. Even though this example involves building a dam to provide a water resource, it shows how vital water support can be to a country or region in phase V and phase 0 operations. This project brought a major boost of support to the region as a strategic initiative to win the hearts and minds of the people. Ventures such as the Kajaki project is an initiative that a geographic Combatant Commander (CCDR) can use as part of his steady state operations for the region (Phase 0 activity) in conjunction with his Theater Campaign Plan (TCP) or as an initiative that can be used as part of stability operations during the transition phase (Phase IV - V activity) of an operation.

This supports another reason to believe that with appropriate water sources in place within a theater of operations, there would be little requirement for military forces to have a reliance on bottled water. An initial unit basic load (UBL) of about 3 days of supply (DOS) of bottled water would be enough, and then we could establish ROWPU operations from legitimate

[15] Tony Perry, "Afghan Dam a Monument to US Challenges," *Daily Press Newspaper*, (September 7, 2010): 11.

water supply sources in the host nation country to furnish the rest of our water needs. Looking through the lens of an operational planner, a dam built during Phase 0 (steady state) operations in 1953 can help U.S. forces during Phase I - III planning 50 years later in Operation Enduring Freedom (OEF). In addition, this type of endeavor can extend the operational reach of the CCDR within a theater of operations. Having a dam at Kajaki increases a planner's flexibility to arrange operations. The dam provides an additional water source on the ground for military forces to use and purify water. This gives the commander the flexibility to bring in water purification capability as needed and permits transportation resources to be used more freely, effectively and efficiently.

In 1992, U.S. forces provided humanitarian assistance and disaster relief to Somalia as part of Operation Restore Hope, which later turned into a Peace Keeping/Peace Enforcement Operation. During that time frame, "Somalia had primitive airfields, barely usable seaport, disintegrating road networks that did not line population centers, and roadways rendered impassable by fallen bridges and washouts. There was no electricity, no water, no food, no government and no economy." U.S. forces provided bulk water along with the mission of receipt, storage and issuance of bottled water.[16] During this operation, purified potable water was a high priority for the Joint Task Force (JTF) Commander providing support.

> The U.S. Marines and Army conducted ROWPU operations using water from the Indian Ocean, local wells in the Somalia area, and wells dug by U.S. Army Engineers. They needed to produce over a half million gallons of water each day. This water was stored and then transported to various parts of Somalia in support of the JTF operations being conducted. They were providing bulk water operations utilizing ROWPUs at over 5 different locations throughout Somalia.[17]

[16] Lamont Woody, Major, US Army, "Coalition Logistics: A Case Study in Operation Restore Hope" (MMAS Thesis, US Army Command and General Staff College, 1994), 59.

[17] Ibid.

Clearly increasing the ability of the Commander to extend the JTF's operational reach, the water operations provided direct support to the civilian populace and all military forces involved in the completion of the mission.[18] Numerous nations provided packaged water for the relief efforts. Some shipped bottled water in containerized boxes, and others shipped it in shrink wrapped pallets. Overall, this was a successful operation when looking at the water support provided. Bottled water became the preferred method of water due to its perceived taste, but there were a lot of lessons garnered from this operation in water management, and improvements to be developed in ROWPU operations, including NATO standardization of water packaging.[19] This operation also required the JFC to look at how he would arrange his capability (Arranging Operations) to flow into theater within the developed TPFFD. Deciding what capabilities were needed and what time frame they were needed, is very critical. The JFC and logistics planners ensured that the right mix of security forces along with logistical elements flowed into the AOR at the appropriate time. Thinking about the best arrangement helps determine the tempo of activities in time, space, and purpose. Logistic sustainment is crucial to arranging operations and must be planned and executed as a joint responsibility. Water is a key part to this effort.

The above are just some of the significant achievements that U.S. forces have been directly involved in, or been limited by, based on their water requirement needs. These needs are critical requirements as defined within Dr. Strange's theory of Critical Capabilities-Critical Requirements-Critical Vulnerabilities. The history of water in military operations is a significant one that cannot be overlooked by military planners. The water purification technology that has been developed over time is one that is relevant to all military forces, whether conducting

[18] Ibid., 123 - 126.
[19] Ibid., 173 - 174.

combat operations or humanitarian assistance. It is an enabler for all JFCs to conduct their mission in a given environment or scenario.

Cost/Resources

Cost and resource requirements are important factors to consider regarding the choice of water source in military operations and HA/DR efforts.

> On the whole, neither the up-front nor the life-cycle costs of bottled and ROWPU-purified water are systematically costed out because the assumption has been that, according to their design, increasingly mobile units like the U.S Army Stryker Brigade Combat Team (SBCT) do not have the built-in capability to handle packaged water in contingency operations and instead are meant to rely on bulk water purified through ROWPUs, which is considered to be a free commodity. However, the reality is that units today consume a large quantity of bottled water. Indeed, bottled water has become the norm in both the training base and contingency operations.[20]

The dollar costs and resources that U.S. forces expend to provide bottled water is one of significant impact, not only to the military services budget providing the resources, but also to the overall DoD/U.S. government budget. Even in the commercial industry, water is a high dollar value commodity. It is an enormous multimillion dollar and growing business. It is reported that

> U.S. sales in bottled water elapsed 170% between 1997 and 2006, $4B to $10.8B globally. Bottled water is $60B a year business. In 1987, U.S. per capita consumption was 5.7 gallons; by 1997 it was 12.1 gallons; 2006 according to a Beverage Marketing Corporation it was 27.6 gals. Bottled water sales surpass beer and milk in the U.S. and by 2011 expected to surpass soda (which Americans drink more than 50 gallons per year).[21]

[20] Army Environmental Policy Institute, *Sustain the Mission Project: Resource Costing and Cost-Benefit Analysis* (Arlington: AEPI, 2006): 17.

[21] Royte, 4.

Using Dr. Strange's theory, bottled water has become a critical requirement (CR) for not only military forces, but also for the American people to use in normal everyday life. Another major factor behind the use of bottled water and the impact it has on the U.S. market is the use of oil to produce the plastic bottles. The U.S. market imports approximately 17 million barrels of oil per year to make water bottles for bottled water.[22] As oil costs continue to rise, so will bottled water costs.

At the strategic level of the military, the Joint Chiefs of Staff have said that we must be able to provide water support in a more economical and efficient way. As a military force we must get "more bang for our buck" especially in an environment of constrained resources. Joint concepts and doctrine are focusing more on reducing resource expenditures and spending, as stated in the Joint Concept for Logistics. It states, "A key component for successful support to the joint force is affordability. Joint logisticians must understand the cost drivers in their logistics solutions, and be constantly aware of the balance between cost efficiency and mission effectiveness."[23] This level of reform will definitely impact the budgets of the Combatant Commanders (CCDRs) and Service Chiefs. The Army, who is a primary user of bottled water in military operations, has spent millions, if not billions, on bottled water. In the late 1990s, "…bottled water contracts cost the Army about $2.00 per gallon as opposed to reverse osmosis water purification unit (ROWPU) water at $0.03 to $0.06 per gallon."[24] This equates to a vast sum of money that U.S. forces pay to provide bottled water in support of military missions. In fiscal year (FY) 2005, while conducting military operations as part of Operation Enduring Freedom (OEF) in Afghanistan, projections by the U.S. Army for the amount spent on bottled

[22] Ibid., 139.
[23] Joint Concept for Logistics, 17.
[24] Wyatt, 1.

water was $190 million dollars.[25] Procurement and supply of bottled water has reached astronomical proportions. As evidenced in our support provided for Operation Iraqi Freedom (OIF), contracts for bottled water have cost the U.S. government millions of dollars. "The U.S. government has handed out upwards of $6 million in Blanket Purchase Agreements (BPA) to contractors that supply water to U.S. forces."[26] Despite this massive amount of expenditure, there is no concrete evidence that bottled water is safer than any other type of water (tap or ROWPU). In addition, there is no viable evidence showing that bottled water sold in the United States is neither cleaner nor safer than most tap water.[27]

Resource constraints can have a tremendous impact on the JFC's Operational *R*each. The JTF may not be able to perform its sustainment mission of providing food, water, and other support, due to reduced funding and other restrictions. In the future, we may anticipate that JFCs will have to plan and execute missions without an unlimited checkbook to support the operation.

As we continue to look at the strategic level impact, we must also look at the cost to move or transport a commodity such as bottled water. It requires significant resources and budget to move supply commodities to theaters of operation in support of wartime contingencies or disaster relief/humanitarian assistance. The Commander, United States Transportation Command (USTRANSCOM), is the Combatant Command (CCMD) responsible for transportation of personnel, equipment, supplies, to provide support to Warfighting Combatant Commanders. Transportation costs to move personnel and materiel via air, sea, train, or by other methods is extremely costly, and in a wartime environment those costs may get increasingly higher. As the Army experienced in support of Operation Iraqi Freedom (OIF), "the very high

[25] Drew Downing, *Expeditionary Water Packaging System (EWPS)* (Warren, MI: US Army Tank and Automotive Command (TACOM), 2005).

[26] US Department of Justice Office of Public Affairs, *Department of Justice Press Release* (Washington, DC: US Department of Justice, 2010): 1-2.

[27] Ibid.

charges for airlift to Iraq did draw significant attention at the top levels of the Army, putting tremendous pressure on the Army's logisticians to find ways to reduce air shipping costs. This pressure produced many ideas, some of which might have significantly hampered support."[28] These enormous costs are not new to the Army or any other service, but in a resource constrained environment, it is not prudent to continue with this method of resource expenditure, without looking closely at cost saving alternatives.

As the JTF continues to analyze the effect of water on campaign design and its impact on operational reach, planners must understand that water, just like other supply commodities, has a cost associated with it when it comes to shipping and moving it inter-theater or intra-theater. For example, the cost of moving fuel as a commodity is calculated by more than just the cost at the pump, and similar attention should be paid to the cost of moving water. Another factor that government organizations take into consideration is force protection, which enables the military to secure convoys and high value commodities being transported. Examples of other factors include transportation by fixed or rotary wing aircraft, and the loss of life if attacked by enemy forces along supply routes. "It would be misleading to think that the cost of importing water is insulated from these other factors, given that water constitutes a significant portion of supply convoys."[29] Currently in Afghanistan, there is a significant cost associated with the manpower, equipment, force protection, and method of transport when it comes to resupplying the military force with bottled water. These additional factors are what logistical planners need to focus upon to ensure that the operation goes successfully. In fact, former USMC Commandant General

[28] Eric Peltz and others, eds., *Sustainment of Army Forces in Operation Iraqi Freedom: Major findings and recommendations* (Fort Belvoir, VA: Defense Technical Information Center, 2005): 83.

[29] Will Rogers, "Afghanistan U.S. Marine Corps Energy Water," *CNAS*, http://www.cnas.org/blogs/natural security/2010/03/fully-burdened-cost-water.html (accessed November 2010).

James Conway said in 2009, "hauling water makes up 51 percent of the logistical burden."[30] This resulted from a Marine Corps assessment that looked at the fully burdened cost of delivering essential supplies to Marines in Afghanistan. Given the size of the logistics tail and the cost of fuel, water, and other commodities being distributed across the theater, the Marine Corps concluded that they should focus on "finding solutions at the tactical edge," including using indigenous sources of water wherever possible, and investing in efficient water technologies at the forward edge of the tactical spectrum in order to keep costs at a minimum.[31] USMC key leaders have taken such a hard look at the cost of supplying water to our military forces, and how they can reduce this cost. In fact, General Conway told an audience at the Naval Energy Forum in October 2009, "that purifying water in Afghanistan can potentially take 50 trucks per week off the road, which could translate into fewer troops needed for force protection, significant fuel savings from taking those trucks off the road and reducing the military's vulnerability to attacks against its supply convoys."[32] The overall take away from all of this, is that calculating the costs of any supply shipped to and within a combat theater, is rarely cheap, and water is no exception. Water should not be regarded as if it is inexpensive, in light of it just being water.

One of the best options to reduce costs and other resource intensive factors is to produce water at the point of origin, which extends our military force operational reach. This has been brought to reality in many parts of Iraq. Multi-National Forces-Iraq (MNF-I) established a contract with the Oasis International Waters Incorporated to run bottled water plants in Iraq. These plants are owned and independently operated by Al-Morrell Development Inc. They are operating six plants across Iraq producing water consumed by U.S. and coalition forces. These

[30] Ibid.
[31] Ibid.
[32] Ibid.

plants have helped to reduce the number of military or contract trucks on the road transporting water to military forces in Iraq. An example of this bottled water plant working in Iraq:

> Oasis produces water by taking the raw water from lakes, rivers, or wells, chlorinating it to kill bacteria and then purifying it using reverse osmosis. The bottles are made on site by sending plastic pellets through a blower to form the one liter bottles. Oasis on site lab checks the water for containments every two hours to ensure it meets contract specifications and military veterinary service inspectors check them every six months to ensure compliance. The lab keeps a sample of water from every test performed on site for six months.[33]

In contingencies, cost and resources are important because they encompass water tests, transportation, security, contractual requirements, and other important factors that must be considered when developing what final bill will be generated.

Planning Considerations

Planning for support operations and HA/DR in an austere environment requires a unique solution based upon the military problem. Water is a challenge that must be met and planned for by JFCs and logistical planners. It cannot be overlooked, because numerous lives and the overall mission depend on getting it right up front. Sustainment concepts acknowledge the importance of paying close attention to water distribution now and in the future. The Army Functional Concept for Sustainment states, "…the future force requires water to survive but distributing it becomes a major consumer of vital and often limited transportation resources. To save lives,

[33] Danny L. Tindle, CW3, US Army, "Oasis Bottled Water Plants" (Memorandum for Record, Baghdad, Iraq: Headquarters, Multi-National Forces-Iraq, 2006).

free up distribution assets and streamline production of water, new technologies must be researched and developed to maximize the production as close to the point of use as possible."[34]

As stated above, water supply is something that has to be planned with the greatest of detail in order to ensure that all support options and details are taken into consideration. A major concern is how the military distributes water, maintaining our ability to employ operational reach and arranging operations, while allowing the JFC flexibility, without over burdening all available resources. Water is something that will be needed for the future force to operate, survive, and win during any conflict or engagement. In addition, water is used to provide humanitarian or disaster relief support. "In most situations, water distribution is the 'weak link' of the water support system. Moving water from the production and storage sites to the user can be equipment and manpower intensive. Joint forces must make efficient use of all available assets in conducting water distribution operations."[35] Transporting water from any storage location to a user can involve several methods of delivery and different methods of packaging the water product (i.e. bottled water, water cans to 5,000-gallon semi-trailer mounted fabric tanks (SMFTs), and 2,000-gallon load handling system compatible water tank racks - "Hippo").

> Getting water to the soldier in the individual fighting position is the critical link in water distribution operations. If this link fails, the condition does not matter of the purification, storage, and distribution assets at brigade, division, corps, or echelons above corps. Throughout military history, the majority of war casualties have been from disease and nonbattle injury. This can be drastically reduced by ensuring that soldiers have adequate supplies of potable water.[36]

A reality of the distribution process is that moving water from a military water purification source is a challenge for planning, because joint planners take into consideration that

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[34] US Army Training and Doctrine Command (TRADOC), *The United States Army Functional Concept for Sustainment 2016 - 2028 TRADOC Pamphlet 525-4-1* (Fort Monroe, VA: Department of the Army, 2010): 11.

[35] Sustainment Battle Lab, *Distribution Seminar Report.* (Fort Lee, VA: US Army Combined Arms Support Command, 2009): 6-6.

[36] David L. Bruen, "Water Operations Overview," *Quartermaster Professional Bulletin* (Spring 1994): 2.

some military forces do not like the taste of ROWPU water. This factor puts a burden on most planners to develop plans that incorporate the movement and shipping of bottled water. The logistics associated with transporting bottled water into an area of operation (AOR), places a heavy burden on force protection requirements, force health protection, financial resources, and transportation requirements. As we will discuss later, part of the potential solution, is to have water packaging collocated with water treatment at all times. This may make water more palatable by eliminating any bad taste from water storage and distribution systems, and significantly reduce or eliminate the need to transport bottled water. Planners with requirements for movement of bottled water should consider that transportation of bottled water utilizes approximately 30-60% of all truck assets and contributes to overcrowded main supply routes (MSRs) or ground lines of communication (GLOC) in a theater of operation.[37] This distribution problem is not just limited to the Army, it has also been noted by the Marine Corps that they too do not have adequate water distribution equipment in their inventory.[38] If the military can find other means to decrease the amount of bottled water and bulk liquids requiring transportation through the distribution system, such as advanced fuel technologies (fuel cells or onboard water generation systems), the burden of not enough resources or force protection requirements will also decrease.

Joint planners have to consider a variety of factors when determining what type of distribution or support capability will be put in place, once in the operational area. This will require the understanding of the operational area and what type of sustainment will be established and maintained throughout the operation. Planners must think about the amount and

[37] Downing.

[38] United States Marine Corps Engineer School, *Trip Report (provides details of temporary duty trip to the Joint Water Resource Management Action Group (JWRMAG) #25 held 8-10 June 2004)* (Memorandum, United States Marine Corps, 2004): 2. Hereafter cited as JWRMAG #25.

type of distribution network they will need in order to move the water throughout the area of operations. Planners will also need to consider waste stream management and force protection associated with water distribution. These topics will be covered in greater depth. Planners who develop this arrangement of distribution capability facilitate the premise of Arranging Operations. Specific distribution capabilities will need to be built into the TPFFD. Planners will need intransit visibility and asset visibility of all support capabilities that they have decided to deploy and employ within the area of operations. In some instances these capabilities will need to be phased into the operation over time. The phasing will ensure that as the command builds that joint capability it will develop and mature in support of the operation, thereby enhancing flexibility and unity of effort during execution.

> Critical to the success of the entire operation is timely and accurate time phased force deployment. However, the dynamic nature of the operational environment may require adaptability concerning the arrangement of operations. During force projection, for example, a rapidly changing enemy situation may cause the commander to alter the planned arrangement of operations even as forces are deploying. Therefore, in-transit and theater asset visibility along with an en route planning and rehearsal capability are critical to maintaining flexibility. The arrangement that the commander chooses should not foreclose future options.[39]

Because of the significance of arranging operations, joint planners will continue to tackle this distribution issue using various methods, primarily through contract support. During operations in OIF, joint logistics planners established contracts with Kellogg, Brown, and Root (KBR) to distribute water and supplies throughout the theater of operations. One problem resulting from KBR's support mission was that "KBR's operational readiness rate for trucks was much lower than expected. This low operational readiness rate is believed to have contributed to

[39] Joint Forces Staff College Student Text 1, *Joint Staff Officers Guide, AY 2010 - 2011, Pre-decisional Draft.* (Norfolk, VA: Joint Forces Staff College, National Defense University, 2010): 4-49. Hereafter cited as the Joint Staff Officers Guide.

the reduced rate of distribution of supplies and water across the battlefield."[40] The below quote from an officer serving in OIF, exemplifies the challenge that logistics organizations had in Iraq with handling bottled water. They were eventually able to reduce some of the challenges, but this is a clear example of why we need to employ the use of more bulk water.

> When we first got there, all the bottle was coming in from Jordan. Bottled water cases were $12.50 a case from Jordan. The contract had already been established to put one up in Al Asad, a bottle water plant. That reduced our cost to $3.50 that was – just to give you an idea of the cost factor. And most soldiers probably drinking a half a case of bottled water a day, so you add that up, it's quite a bit of money and it was quite an ugly commodity. Bottled water is just heavy, squishy, likes to fall apart. If it's been sitting out on a pallet yard and the sun's been beating down on it and the plastic starts to deteriorate and the paper gets wet and then it starts to fall apart. Pretty soon we had literally thousands of bottles of water on the side of the road; the enemy was burying IEDs in bottled water for God's sakes. Literally, we – on our first visit out to one of our FOBs, I think we went to FOB Heat – we stopped here and watched the PLS come in and the bottled water just falling over, falling off, and the guys were off lifting it by hand, putting it down and boxing and tri-walls and then I get back to base and I started getting e-mails from guys at the other end, they're sending me pictures of bottled water…[41]

[40] Peltz and others, eds., 25.

[41] US Army Combined Arms Support Command (CASCOM), *R-CAAT Series 593rd Sustainment Brigade Western Iraq Lessons Learned LPD Presentation Transcript* (Fort Lee, VA: US Army CASCOM and Center for Army Lessons Learned (CALL)), 2007): 46-48. Hereafter cited as CASCOM Transcript.

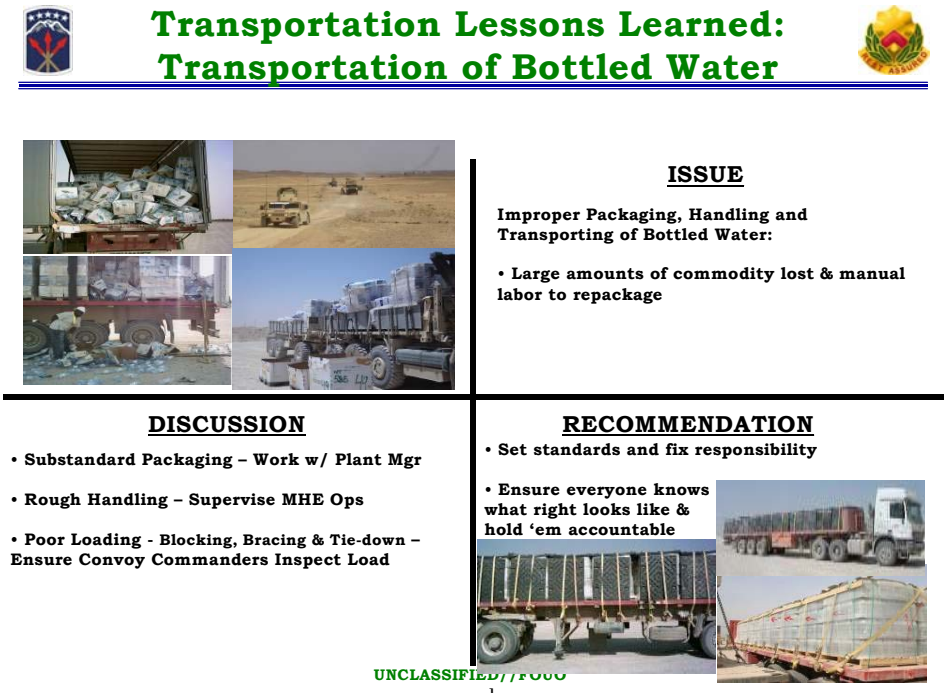


Photo above: Briefing chart from USA, 593rd Sustainment Brigade interview discussing lessons learned in Iraq, which included lessons from transporting bottled water.

Another concept that should be taken into consideration by logistical planners of combat operations or HA/DR, is "push" versus "pull" system. The push system means that the higher supply level forecasts the need and requirements of the lower level and continues to send various supply commodities in frequent intervals to the supported organizations. This can be done whether the supported organization needs the supplies or not. At times, the supported organization may not have enough space, manpower or the required demand for the item being shipped to them, but because of the push system, they will receive it anyway. The pull system means that the supported organization forecasts its need or requirements and sends this information to its higher level of support, requesting that they send the needed commodity within a given time frame. This system ensures that the supported organization has the space, manpower and the demand for the commodity they are requesting, because they are in charge of forecasting their needs. The pull process has been a proven method to ensure that the supported

organization is not over saturated with commodities that they cannot move, distribute, or handle as an organization.

A JAWS course guest speaker provided a great briefing to the class on the benefits of the pull method. The guest speaker discussed the support provided during Operation Unified Assistance (UAE) 2004 - 2005. During Operation UAE, the guest speaker outlined the problem with private sector companies wanting to push disaster relief support materials to his organization as his unit provided support to the people of Sri Lanka, after they were devastated by a tsunami. This included sending hundreds of pallets of bottled water. The General explained that pushing that amount of bottled water to his unit, at a time where the environment was extremely austere, with very little support capability and infrastructure in place, put a burden on the flexibility of the commander. This action tied up all available resources. This forced the need for a just in time logistics system or pull system in order for his command to request what they needed to be able to provide HA/DR support when they needed the commodity to be delivered. This in turned freed up many assets and resources along with giving the commander the flexibility that was needed to support the operation.[42] In the language of joint doctrine, using a pull system enhanced the commander's ability to effectively apply the operational element of arranging operations in a way that allowed for mission accomplishment.

Providing water to support military forces and civilian personnel is a critical capability (CC) that must be employed and executed into the operational design plan. This is directly in line with thoughts that have been articulated within Dr. Strange's theory of critical capability (CC) - critical requirement (CR) - critical vulnerability (CV). It is a CR that is needed by our forces and the personnel we will be supporting in combat and within HA/DR type operations.

[42] Guest Speaker, "Case Study of Multinational Planning and Operations in Support of CSF-536" (lecture, Norfolk, VA: Joint Forces Staff College, March 15, 2011).

The water distribution issues can present a CV to our forces at all levels. If our adversaries develop ways to disrupt or interfere with our distribution pipeline and network, it could have a serious effect on the JFCs ability to assert his Operational Reach.

The previous vignette demonstrates that handling bottled water during a contingency or humanitarian assistance operation is a difficult task. Packaging of bottled water is another critical distribution nightmare for joint logistics planners. Lack of proper packaging will not contribute to the JFC expanding his operational reach capability. Distribution of bottled water across the military battlefield will continue to be a challenge.

> Packaging to support the movement of bottled water on flatbed trucks and in containers has not been developed for battlefield distribution. Poor bracing and blocking could result in half the bottles in a container coming loose and spilling out of their packaging. When this happens, materiel-handling equipment cannot be used to unload the container. Typical tie-down techniques did not work well in Iraq for loads of bottled water. Tie-down straps for pallets might come loose over the very rough roads, requiring further tightening. The extra tightening (or even initial tightening) might crush some bottles, getting cardboard boxes wet and causing them to break down, leading to additional loosening of the load. The load would be tightened yet again at the next Convoy Support Center (CSC), leading to another round of load disintegration. The distribution of water from sources of production and the Army's large storage containers to individual vehicles and personnel remains difficult.[43]

Joint Force Commanders and their planners must make critical decisions when trying to discern which capabilities to employ and the timing of their use. Planners have to integrate the water production capability and synchronize the requirements with the distribution needed, force protection required, length of the logistics tail, and length of the operation. This will all be based on the proper alignment of time, space, and purpose, consistent with the operational element, "arranging operations". JFCs must establish their priorities and match the capabilities needed to support those priorities. Employment of water support capabilities will be initiated or delayed based the plans outlined by the JFC and logistics planners in the development of the campaign's

[43] CASCOM Transcript, 34-35.

operational design. This is a clear example of the use of timing and tempo, which is another element of operational design that is closely related to Arranging Operations.

Force Protection

The analytic discussion of Dr. Strange's critical vulnerabilities (CV) reminds us that force protection is a major planning consideration that must be reviewed and employed in order for the operation to be effective. Logistics planners moving water, a critical requirement (CR), or any supply commodity in convoy operations to military forces or civilian locations must plan and provide protection for those transportation assets. In order to ensure that the support lines of communication (LOC) are not interrupted, they must be secured. A good example of military forces attempting to secure LOCs is in AORs such as Pakistan. In Pakistan insurgents have been attempting to attack U.S. resupply convoys along the ground lines of communication (GLOC). Fuel and other supply convoys were struck several times. These attacks have limited some U.S. support capability and caused commanders and planners to implement better security measures across the LOCs. This is a continuous problem that has been addressed in the operational area and one that requires diligent focus by commanders and planners.[44]

In accordance with the Army's Functional Concept for Sustainment in the years 2016 - 2028, the Army sees the following challenge for security of sustainment and protection of this function. Regarding security of sustainment,

> (1) Future Army sustainment forces require the capability for self-securing formations capable of providing full range of security on a 360 degree aerial,

[44] STRATFOR, *"Global Intelligence"*, STRATFOR, http://www.stratfor.com/memberships/172895/geopolitical_diary/20101004_uss_logistical (accessed November 2010).

surface and subsurface basis, to sustain future operations and maintain freedom of movement in full-spectrum operations.
(2) Future Army sustainment forces require access to joint, service, and organizational fires, sensors, platforms, weapons, measures, and mission command systems to enable them to traverse within the joint operations area between the operational and tactical level.[45]

In addition to security, protection of assets is also critical,

> (1) Future Army forces require the capability to secure and protect sustainment assets and personnel in full-spectrum operations in the future operating environment.
> (2) Future Army forces require the capability to provide early warning of offensive indirect fires directed against sustainment sites and convoys to maintain freedom of action in full-spectrum operations in the future operating environment.[46]

The Marines, similar to the Army, see the above imperatives as critical requirements for the future sustainment mission.

Photo above: Supply convoy in Afghanistan[47]

[45] US Army Training and Doctrine Command (TRADOC), *The United States Army Functional Concept for Sustainment 2016 - 2028 TRADOC Pamphlet 525-4-1* (Fort Monroe, VA: Department of the Army, 2010): 31. Hereafter cited as TRADOC Pamphlet 525-4-1.
[46] Ibid.
[47] Ibid., 11.

Waste Stream Management

> Every second of every day in the United States, one thousand people buy a plastic bottle of water, and every second of every day one thousand people throw one of these bottles away. That adds up to more than thirty billion bottles a year, and tens of billions of dollars in costs to consumers. People usually say they buy bottled water for four major reasons: fear of their tap water, convenience, taste, and style. The news is filled with stories about water contamination and so we start to fear that our tap water is polluted by things we cannot see or smell. We seek the convenience of little portable packages of water that are available wherever and whenever we want them because we can no longer find a clean, working water fountain. Sometimes we really don't like how our tap water tastes. And we're misled by intensive advertising into believing that this or that brand of commercial water will make us healthier, skinnier, or more popular. So we've turned to the bottle, convinced that paying a thousand times more for individually packaged plastic throwaway containers of water than for readily available tap water is an act of rationality rather than economic, environmental, and social blindness.[48]

The above is an extract from a book that discusses our obsession with bottled water in the United States. These same obsessive traits apply in military operations as Soldiers, Sailors, Airmen, and Marines coming from the USA, utilize bottled water as a main source of supply in support of mission requirements. One area that does not generate a lot of discussion is what happens to all of the plastic bottles after the water has been consumed? In the U.S., our cities, towns, and states have recycling programs and waste disposal organizations that pick up and dispose of our trash and recyclable products on a daily basis. During a contingency operation, deployment operation, or HA/DR support mission, we do not have the resources available to dispose of plastic bottles in the same way. A vast majority of the undeveloped countries that we support do not have a recycling program. Disposal of trash and plastics is another mission critical element that JFCs and logistics planners have to consider.

[48] Peter H. Gleick, *Bottled & Sold, The Story Behind Our Obsession With Bottled Water* (Washington, DC: Island Press, 2010): XI - XII.

When military forces use bottled water, we have to plan on how we will dispose of the plastic. In most recent operations in Iraq and Afghanistan, burning of trash and plastics has been the solution. This is not the optimal solution, due to the effect it has on the environment and the unhealthy toxins that are produced in the air from burning plastics. The waste stream is another challenge that the military assumes when using sources of water other than bulk water operations. What we have learned from examples such as cited below, that the military has a long way to go in order to figure out what we must do with disposal of plastic bottles. The large majority of all plastic water bottles that are used in a contingency operation will end up in a waste disposal area that is linked to a burn pit. Exposure to the burning of plastics and other trash is potentially harmful to the long term health of our force.

The Government Accountability Office (GAO) visited four bases in Iraq, from September 2009 through October 2010, and investigators reviewed planning documents on waste disposal for bases in Afghanistan. Unfortunately, none of the Iraq bases that were visited were in compliance with military regulations. All of the bases burned plastic which generated harmful emissions. This all happened, despite regulations against these procedures. According to news sources,

> The emissions have been the source of controversy as troops have complained about a host of problems, from cancerous tumors to respiratory issues, blaming exposure to burn pits. Military officials have denied any consequential effects on most troops. The military, the report concluded, has been slow in using alternatives and has not considered the long-term costs of dealing with subsequent health issues.[49]

Military forces have vast training on planning considerations other than budget. These considerations include environmental policies, doctrines, and regulations governing recycling and management of waste materiel. What we have seen is that once military operations are

[49] Adam Levine, "Audit: Military using potentially harmful methods of burning trash," CNN.com, http://www.cnn.com/2010/US/10/15/military.burn.pits/index.html?hpt=Sbin (accessed October 18, 2010).

underway, none of the policy, doctrine or regulation seems to apply. Military forces are left to implement and manage their own directives and initiatives with very little oversight. "Army units in Iraq and Afghanistan have found themselves focusing their efforts on providing clean water, managing sewage, and collecting trash in an effort to convince locals of their good intentions and to provide fewer reasons for them to resist the U.S. presence or join an insurgency."[50] The leadership in our military force structure has situational awareness of this problem with water bottles littering base camps, supply routes, and all over the terrain that we operate in as a military force, but little has been done to fix the issue thus far.[51]

Waste stream management, if done effectively and correctly, can be an element that the JFC and planners can use as an advantage to build trust and respect with the local populace of the country where we are conducting operations. If not tended to, poor waste stream management can put us at a disadvantage for use of another nation's land. Ability to use the land and not endanger the environment shows that despite U.S. forces conducting operations in their backyard, the U.S. military has done its very best to mitigate any loss of property, damage to the environment, infrastructure or loss of resources. This attention to detail provides great benefit in developing an operational campaign that helps to win the hearts and minds of the people. In addition, this attention also develops a great transition during Phase IV through Phase V, and eventually back to Phase 0 type operations. Transition of a program or operation that has not damaged the environment and allowed the country to get back to a steady state environment provides a good advantage for the U.S. military when conducting support operations.

[50] David E. Mosher and others, eds., *Green Warriors Army Environmental Considerations for Contingency Operations from Planning Through Post-Conflict* (Santa Monica, CA: Rand Corporation, 2008): 55.

[51] Robert J. Mayberry Jr., COL, US Army, "Is Bottled Water Sustainable in Contingency Operations" (Carlisle, PA: USAWC Fellow with the Army Environmental Policy Institute): 2.

To summarize, good waste stream management should be seen as part of arranging operations. It will give the commander more flexibility in determining the type and number of units that will be needed in the operational area at any given time, specifically logistics organizations. Logistics organizations, military or tactical, will assume the primary workload for handling the waste stream management process in support of military operations being conducted within the theater.

CHAPTER 2
ANALYSIS OF WATER SUPPORT CAPABILITY

Military Dependency on Bottled Water

"Whiskey is for drinking, water is for fighting."

– Mark Twain

> The reality is our Soldiers do not like the taste of bulk water, and they have begun to expect bottled water in the field. The logistics associated with transporting bottled water into the AOR brings into play Force Protection, Force Heath Protection, Cost, and Vehicle Usage. If tactical water packaging were to be collocated with tactical water treatment we could make the water more palatable by eliminating any taste compounds imparted by the Water Storage and Distribution Systems, and significantly reduce if not eliminate the need to transport bottled water.[1]

The quote above is the very essence as to why our forces do not like to drink bottled water. As previously mentioned, the military, as a representation of the American society, bring their tendencies and biases into the military structure without hesitation or reservation. This aspect is what leads to a dependency upon bottled water to fulfill mission requirements and support objectives.

In 1991, during the Gulf War Crisis, a large amount of bottled water was used by military forces under the auspices of "promoting quality of life enhancement". The use back then is one of the factors that helped promote the misperception that bulk water from ROWPU's is poor in quality and taste. Military forces did not like the ROWPU water, because they said it tasted different from bottled water. One of the major factors affecting the ROWPU water at that time

[1] Wyatt, 7.

was temperature; taste of chlorine to combat contamination was too strong; while water storage and distribution equipment placed an unpleasant taste into the bulk water.[2]

At times there are multiple reasons why military forces relied on bottled water in the theater of operations. As discussed earlier, sometimes it is due to the forces feeling more comfortable having a plastic bottle of water vice having bulk water delivered to them from a ROWPU. Some JFCs, logistical planners and resource managers are willing to forgo the enormous costs associated with bottled water if it meets the requirements of the force structure and satisfies the troops, while fitting into mission guidelines and support structures. Other times it may be due to operational necessity or strategic planning, as in the case of NATO troops conducting military operations in Afghanistan. NATO leadership was aware that imported bottled water was cheaper than the bottled water from producers inside Afghanistan. Despite the ability to provide cost savings by the imported bottled water, strategic guidance given by the NATO Commander in Afghanistan found that purchasing bottled water locally helped to stimulate the Afghanistan economy.

Stimulation of the economy, a strategic goal, was an effort to assist in winning the hearts and minds of the people and to achieve U.S. objectives of getting Afghanistan to be a vital economic country. This is definitely a challenge at times, because some Afghanistan water plants did not meet the same water standards and may have some bacteria that the American immune system is not able to process well. This is an issue that all planners and logisticians continue to work to solve.[3] The following is another example of a military operation where we had ROWPU water available to support the force, but based on conversations with the troops the leadership decided that more bottled water was needed. This would be a morale booster for the

[2] Downing.
[3] Sydney J. Freedberg Jr., "The bottled-water problem," *National Journal* (February 2010).

force, but not necessarily practical from a planning aspect or fiscally responsible. The below is a quote from a history interview report with the J4, JTF 180, Operation Uphold Democracy, in support of Haiti in 1994:

> The 10th Mountain, as they were coming in, really didn't have any—didn't have the capability to pick up water and move it around until they got their equipment which was on the ships. So we had a distribution problem with water. We solved that—what we did, we went back to Bragg and picked up the water that was rigged for airdrop and put it on the next available plane, along with some gallon jugs of water that we had already bought through a contingency contract, and some bottled water. And we flew that in—arriving on D+1…only one other time, a soldier that the CG asked him, "If there's anything that I need to do, what would he like him to do for him?" And he said, "I'd like to have bottled water." So even though we had water, and had it distributed, and the water was safe and all that, we still ended up probably with about nine hundred thousand bottles of bottled water. Probably not cost effective, but it was a morale builder for the soldiers, and that was the decision to go ahead and bring in bottled water. It looks like, in future operations; you ought to plan on bringing in bottled water early because of the distribution problems, especially the forced entry. As you are first coming in, you either got to drop the water in, or you've got to get it in the first air land, because the soldiers in a climate like this just won't have the water buffalos and the five gallon cans to be able to supply themselves until they get married up with their equipment. So that first, probably twenty-four to forty-eight hours, we legitimately needed bottled water, and then from then on, it really becomes a nice-to have if you can afford it, and have got the transportation to haul water in by air or by barge.[4]

Warfighter Concerns

> **"You will not find it difficult to prove that battles, campaigns, and even wars have been won or lost primarily because of logistics."**
>
> ***- Gen Dwight D. Eisenhower***

The U.S. military needs to consider the operational and logistics impact of using bottled water as a primary means of support for every mission that is conducted. U.S. military forces will begin to lose their capability and knowledge/skill to purify water in support of operational

[4] XVIII Airborne Corps & Fort Bragg, "JTF-180 Uphold Democracy Oral History Interviews," Oral History Interview, (Fort Bragg, NC: XVIII Airborne Corps & Fort Bragg Training Support Center, 1994): 284.

requirements across the wide range of military contingencies. For every military operation that requires bottled water, there are other possible alternatives to provide water support. JTF Commanders or logistical planners analyze ways to support military forces during all phases of the operation. The resources and costs involved offer some insight as to why we choose bottled water as a first option above all others.

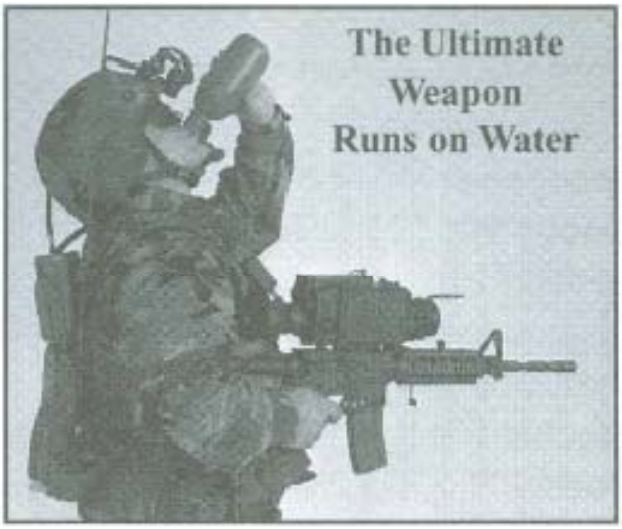
So what are the concerns that warfighters have about bottled water? Some of the major concerns addressed earlier in the paper center around cost, packaging, distribution and most of all taste. After action reports coming out of Iraq (OIF) and Afghanistan (OEF) confirmed these same issues.

> Overall, units producing water in these operations met their goals and objectives. Some supported units who participated in these operations reported critical shortages of drinking water. However, upon further investigation it was discovered that they had an abundance of potable water purified by a ROWPU and their supply of bottled water was low. This again highlighted the problem of getting troops to consume ROWPU water. During the course of past training and real world operations, ROWPU water has somehow received a bad reputation. There is no better process for purifying water than reverse osmosis. It is my belief that the problem is actually the temperature of the water coupled with high Free Available Chlorine and being stored in a rubber/fabric tank that causes the water to be unpleasant to the palate. Bottled water is a tool for the commander to use until the ROWPU is in place and operational and we should not rely on it as our only potable water source.[5]

With the above concerns being reviewed, we must also take under consideration how water production capability is being provided in a theater of operations, and how it will impact a Joint Force Commander's Operational Design of the theater campaign. Specifically focusing on two areas of Operational Design, the commander's ability to arrange the flow of forces and capabilities coming into theater to conduct military operations, better known as arranging operations; or the JFC's ability to project and sustain his force through various resources, also

[5] JWRMAG #25, 2.

known as operational reach. These concerns have impact into the theater campaign design that the JFC develops. His ultimate campaign design plan must support his theater objectives and strategic end states. The JFC's plan will always maintain the right focus in order to ensure that we take care of our ultimate weapon - the Soldier, Sailor, Airman, and Marine.



"The ultimate weapon – the soldier - runs on water… Water decided the battle of Little Big Horn …. Without these commodities, Warfighting systems will grind to a halt."[6]

When looking at arranging operations, we must first understand the context of the definition, or what it means to the JFC. The citation from the Joint Forces Staff College Publication states the following about Arranging Operations:

> The dynamic nature of modern warfare that includes projection of forces complicates decisions concerning how to best arrange operations. JFCs must determine the best arrangement of operations to accomplish the assigned tasks and joint force mission. This arrangement often will be a combination of simultaneous and sequential operations to achieve full-spectrum superiority and the military end state conditions: a) Commanders consider a variety of factors when determining this arrangement including geography of the operational area, available strategic lift, service-unique deployment capabilities, diplomatic

[6] Anders, 9-10.

> agreements, changes in command structure, protection, level and type of other government agencies (OGA) and non-governmental organizations (NGO) participation, distribution and sustainment capabilities, enemy reinforcement capabilities, and public opinion. Thinking about the best arrangement helps determine the tempo of activities in time, space, and purpose.[7]

The impact of water on the operational design element - arranging operations, has relevance as the JFC must decide what capability is needed on ground in theater and at what time the capability can best be utilized. The requirements of the force flow and availability of type forces will play a role and impact what capabilities the JFC can move into theater and how fast combat power and sustainment power can be developed to support mission requirements. If the military mission requires the need for the JFC to have more combat forces readily available and on the ground quicker, then risk may be taken in providing less logistics force structure in the beginning of the operation. The opposite may also be the case, the JFC may determine that the mission will be logistics heavy and will require a more robust logistics capability up front in the force flow as opposed to combat forces. The need for water in support of mission requirements and planning will have a direct impact on what the JFC does during mission planning and force flow planning in support of combat operations or humanitarian assistance.

The impact of water on the operational design element - operational reach, will have relevance as the JFC must decide what capability is needed on ground in theater and how much of that capability can be utilized. Operational reach as a joint logistics attribute - sustainability - provides the JFC with the means to enable freedom of action and the ability to extend operational reach.[8] In the Joint Concept for Logistics, operational reach is defined as "the ability to project and sustain a logistically ready joint force through the deliberate sharing of national and multinational resources to effectively support operations, extend operational reach, and provide

[7] Joint Staff Officers Guide, 4-49.
[8] Joint Concept for Logistics, D-3.

the Joint Force Commander the freedom of action necessary to meet mission objectives."[9] The Joint Forces Staff College text views operational reach as the following:

> Operational reach is the distance and duration over which a joint force can successfully employ military capabilities. Reach is fundamentally linked to culmination and is a crucial factor in the campaign planning process. Although reach may be limited by the geography surrounding and separating the opponents, it may be extended through forward positioning of capabilities and resources, increasing the range and effects of weapon systems, leveraging HNS and contracting support, and maximizing the throughput efficiency of the distribution architecture.[10]

The various definitions of operational reach basically say that the JFC must be able to project his forces to various locations over periods of time and sustain those forces at a rate that will not impact the desired level of effect the commander is trying to achieve. A good example of this impact on operational reach is below:

> In 1990, Iraq invaded Kuwait, and U.S. forces responded. Water-support operations stocked forward locations with bulk potable, ROWPU, and bottled water provided by host-nation support. Post-war analyses focused on several water-support logistics issues. General Norman Schwarzkopf delayed deployment of support personnel to maximize combat forces on the ground, and since most trained water-support personnel were in the Reserves, an additional call up was required.

Use of the total force, active and reserve, was extremely useful to support operations. The reserve component has very robust water purification capability within its force structure. To continue the thoughts on operational reach,

> True shortages were complicated by the terrain, which hindered movement due to a lack of adequate surface transportation routes. There were also concerns over Saudi Arabia and the United Arab Emirates' discontinuing water supplies to U.S. forces. A working group from water resources management drew up a plan to provide water in such a case. The cost exceeded the price of oil. Finally, the length of time (6 months) for the buildup and negotiating for host-nation support may not be a luxury in the future.[11]

[9] Ibid., 4.
[10] Joint Staff Officers Guide, 4-45.
[11] Wyatt, 5.

These types of concerns have direct implications on the JFCs operational reach capability and the desired effect on how those operations are arranged.

Again, this same type of impact was seen during the 3rd Infantry Division's movement from Kuwait to Iraq during OIF in 2003. During After Action Reports, the 3rd Infantry Division was very critical on their capability to store, move and distribute water. Units identified the need to have better storage capability and distribution capability for water. Units also believed that bottled water was the best alternative for the operation during that time frame. Rapid movement from Kuwait to Iraq by these units is also a contributing factor, in addition to allowing ground forces flexibility to distribute water. They did identify that there were challenges in hauling water, both bottled and bulk, due to limited movement assets.[12]

As this example shows, understanding the context of operational reach is important to the JFC. As an operational design element, operational reach will give the JFC capability to do things in support of the theater campaign plan (TCP) design which is key to reaching the overall strategic end states.

Current Joint doctrinal concepts emphasize the responsibility of reducing the logistics footprint is the responsibility of logisticians and Warfighters together. "We need new ways to decrease the requirements for our three biggest bulk commodities; fuel, water, and ammunition. We must research innovative technologies to eliminate our dependence on fossil fuels. We must take advantage of the many methods to locally produce and recycle water for individual and bulk consumption."[13] In order for our future force to remain agile and mobile, we must decrease the logistics footprint, in order to be able to support distributed operations in austere environments.

[12] 3rd Infantry Division (Mechanized), US Army, *Operation Iraqi Freedom Third Infantry Division (Mechanized) 'Rock of the Marne' After Action Report (Final Draft)* (Fort Stewart, GA: 3rd Infantry Division (Mechanized), US Army, 2003): 198 - 201.

[13] Joint Concept for Logistics, 19.

We must rely on better systems that are more scalable and tailorable, while reducing manpower requirements. We must find a way to reduce the requirement for bulk commodities such as fuel and water which will give significant benefits. This can also be achieved through production, distribution, and the ability to recycle the water locally.[14]

In summary, logisticians are challenged to provide services that enable the Warfighter to have the "ability to produce, test, store and distribute bulk, packaged and frozen water in an expeditionary environment."[15] These challenges, in turn, affect the operational planner's campaign design and the ability of a commander to arrange operations with flexibility, reach, and effectiveness.

Water Capability Planning and Doctrine

In order to analyze the concerns that Warfighters may have over our capability to provide water, it would be prudent to conduct additional analysis from a doctrine, organization, training, material development, leadership, personnel, and policy (DOTMLP-P) standpoint. Beginning with a doctrinal and conceptual viewpoint, water is an extremely hard commodity to support on the battlefield during combat operations. It is one of the largest and most important life sustainment commodities that can be provided to our forces and for humanitarian assistance. Commanders and staff at all levels have to be involved and concerned over how this mission will be supported by our forces. It should be addressed in all plans and orders during all stages of sustainment planning. Water is normally a Service specific responsibility, but can also be delegated to whoever the lead Service of a specific operation may be if they have the

[14] Ibid., I-2.
[15] Ibid., C-3.

preponderance of forces in the area.[16] Water support operations are going to consist of purification, storage, and distribution. Distribution will be the hardest task to execute in any operating environment. Early within an operation, we may consider the use of Host Nation (HN) bottled water as long as it has been certified by U.S. preventive medicine personnel.[17] To ensure that military planners are providing the most effective use of water stocks and equipment, planners must be familiar with Service, DOD agency, and JFC water assets and responsibilities. As we look at the doctrinal concepts and publications, even the ones published by the CCMDs, the major pieces of emphasis that are missing is senior leader directive or willingness of Commanders to direct units to limit use of bottled water in favor of alternative sources. The USCENTCOM standard clearly lays out that bottled water is only for the immature theater. Unfortunately, we are eight years into our current operations without a push to get the Warfighting forces away from using bottled water.[18]

U.S. water organizational capability has changed over the years due to the training and modification of equipment. This modification has evolved based on the actions our forces have experienced since Desert Storm/Desert Shield operations. As the Executive Agent for water management of land based forces, the Army has had to change its tactics, techniques, and procedures relative to providing water. The change in these procedures has had a direct effect on how we provide drinking water, both bulk and bottled. The Army has had to design its unit structure to support the current change in techniques and procedures. These changes reflect the requirements to plan, execute, manage, and operate water treatment and bottling plants. The 68th Combat Service Support Battalion (CSSB), which supported the 4th Infantry Division in Iraq, is a

[16] Chairman Joint Chiefs of Staff, *Joint Pub 4-03, Joint Bulk Petroleum and Water Doctrine* (Washington, DC: Department of Defense, 2010), xxi - xxii.

[17] Ibid., xxiv.

[18] United States Central Command, *Construction and Base Camp Development in the USCENTCOM Area of Responsibility (AOR) "The Sandbook"* (Tampa, FL: USCENTCOM, 2004).

primary example of this type of change. This unit not only had to develop, treat, store, and transport water to military forces in an austere environment, but they also had to be prepared to support in built up urban environments. In addition, our forces are now challenged to be water manufacturing plant operators, managers, and transporters. This process goes beyond their normal Military Occupational Specialty (MOS) of water treatment specialist, but U.S. forces as usual, adapt well to changing situations.[19]

Training is another aspect of the development of quality water purification capability. Since, the early 1980s, when the Army transferred the water supply mission from Engineers to Quartermaster Supply personnel, the training for water support significantly improved. It was also a time to replace the 1950s technology equipment and incorporate reverse osmosis technology. The upgrades in doctrine, equipment, and unit structure were tested together for the first time in Egypt during Exercise Bright Star 85 (July-August 1985). Military personnel were also armed with 600 and 3,000 gallon per hour (GPH) Reverse Osmosis Water Purification Units (ROWPUs) and a new generation of collapsible storage tanks and drums, which ensured that all forces received adequate supplies of fresh water. Since this time frame, Soldiers and Marines alike have been trained in providing water for life-sustaining support and humanitarian assistance.[20] The below photo shows Army Soldiers loading food, bottled water, bulk water and other supplies for transportation to Marine forces in Sinjar, Iraq, during OIF. The ability to produce and transport up to 30,000 gallons of bulk water per day is a direct result of the training that has been established over the years in the water production community.[21]

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[19] Samantha Schutz, PFC, US Army, *"Camp Liberty Water Facility Keeps Troops Hydrated,"* Edited by Special to American Forces Press Service, http://www.defense.gov/News/newsarticle.aspx?id=49266 (accessed November 30, 2010).

[20] Anders, 9-10.

[21] Jack A. Tyer, Captain, US Army, "Logistics Support in an Austere Environment: The Mission to Sinjar," *Army Sustainment* 42, PB 700-10-03, Issue 3 (May-June 2010).

Photo above: Armored forklifts unload palletized water that was delivered by armored tractors.

Photo above: Carrier resupplies bulk water for use in the laundry and shower facilities.

The next aspect of water capability development is leadership. Leadership at the Joint and Service component level must understand that in order to maintain our capability of producing and distributing water at a quality level of support will only happen if the right emphasis is put on it from the highest level. Emphasis must be placed on proper training of personnel, planning and management of assets. As a military force, we cannot fall in the trap of being comfortable with providing a bottled water solution to all of our water needs. This is not practicable or suitable for every operation that is conducted. Continued reliance will eventually

lead to the fallacy of believing that we can cut personnel, equipment, and other resources related to providing water. In today's resource intensive environment some may believe, it is practical that we should make cuts, because we will substitute any shortfalls gained with bottled water. As a military force, we must not forget that bottled water adds to higher operating costs, increase in transportation requirements for distribution, manpower intensive and the lack of flexibility for the commander. This in turn will reduce the JFCs operational reach capacity and effect how the commander's arrangement of the operation flows.

The success of water operations by any service will solely be based on the outstanding personnel who are recruited and trained to perform the mission. It has been critical over the years that the highest quality personnel be trained to conduct this water purification mission. The equipment training that they receive will make the services better postured to be able to support deployed forces and provide humanitarian support. Providing quality water is a thankless job, but is one that all will be counted upon to be done right. Planners should continue to be concerned about fuel and food, but they also need to be worried about the force structure for water-support units. It needs to be examined to ensure U.S. forces can deploy the capability quickly when needed. A balance between guard, reserve, active duty, and private sources is the right direction to ensure that the United States has the right capabilities to meet a broad spectrum of water-support challenges (humanitarian, homeland defense, weapons of mass destruction, disasters, war, and so forth).[22]

[22] Wyatt, 5.

Photo above: Soldiers conducting water purification operations.

Policy is another challenging factor when it comes to providing guidance on water purification and the utilization of bottled water. Policy does not clearly specify that the military forces should attempt to utilize bulk water first vice a bottled water solution whenever possible. Maximum effort should be put forth at all times to limit resource expenditures for water no matter what the operational requirement. The Secretary of Defense (SECDEF) has designated the U.S. Army as the executive agent for land-based water management. The U.S. Army policy at the lower command level is to use as little bottled water as possible during military operations. This is demonstrated in the policy published by the U.S. Army Forces Command (FORSCOM):

> (1) Plan for the use of tactical water support requirement for Army forces during the planning phases of an operation. (2) Ensure that tactical water support for other Services, when required to be provided by the Army, is incorporated into OPLANS and CONPLANS or preplanned with inter-service support agreements (ISSAs). (3) Maximize the use of and dependency on tactical water purification,

storage, and distribution equipment in all operations and exercises and minimize dependency on commercial bottled water.[23]

This policy is a clear indication that utilization of bottled water is not the most practical requirement for our forces. Unfortunately, this policy is not readily adhered to or enforced. Army policy also specifies that the Army Surgeon General will (1) Establish potable and non-potable water quality standards, (2) Determine water quality monitoring and surveillance requirements, (3) Test bulk, packaged, and bottled water supplies and approve them for distribution. Lastly, the Commander, U.S. Army Training and Doctrine Command (TRADOC) is responsible for developing all tactical water support doctrine, to include doctrine on the use of commercial bottled water and water packaging systems.[24] This requirement and responsibility is one that should be emphasized to subordinate to level commanders to ensure that the military starts making changes in its support practices. Maximum use of tactical water purification, with minimum use of commercial bottled water is an achievable standard, but it will take all levels of leadership emphasis to accomplish.

"When the well's dry, we know the worth of water."

– Benjamin Franklin

[23] Department of the Army, *Tactical Land-Based Water Resources Management, Army Regulation 700-136* (Washington, DC: HQs Department of the Army, 2009), 4.

[24] Ibid., 1-2.

CHAPTER 3
SOLUTIONS TO THE PROBLEM

"Logistics is one of the most important operational functions. Without theater-wide logistical infrastructure, it's extremely difficult to conduct a campaign or major operation."

-Dr. Milan Vego wrote in Operational Warfare.[1]

Materiel Solutions/Alternatives

The Joint Concept for Logistics has challenged the military community, research and development community, and academia to develop new technologies to assist in the planning and development of water capabilities. This includes local production and recycled water that is available for bulk and individual consumption.[2] This is vital as our military forces venture and maneuver through the 21st century and beyond into a realm of reduced force structure, reduced budgets, and reduced forward presence in numerous locations throughout the world. The joint logistics planner will be required to determine how to best support the military force, provide humanitarian assistance, and conduct operations, all on a limited budget for execution. This is a very tough task in a resource constrained environment. No longer will the open valve of bottled water be an immediate consideration without the immediate thought of how we pay for what we are consuming. The CCMDs and Services will have to work together on solutions that continue to allow flexibility to the Joint Force Commander and do not limit his operational reach within the theater of operations.

[1] Milan N. Vego, *Operational Warfare* (Newport, RI: Naval War College, 2000): 259.
[2] Joint Concept for Logistics, 19.

In Kuwait, the Army Service Component Command (ASCC), Commander 3rd United States Army, is also the Combined Forces Land Component Commander (CFLCC). One of the CFLCC Commander's responsibilities is to provide common use logistics support to the ground forces for all coalition components in the theater (i.e. Kuwait, Iraq, Afghanistan, Qatar, and other countries with U.S. forces present). His subordinate command that executes that mission is the Theater Sustainment Command (TSC). The TSC works very closely with other CCMDS and Defense Agencies to provide this type of support to the theater while conserving and saving resources.

> Integral to the TSC success is its ability to leverage and synchronize support from joint and strategic partners (such as, the U.S. Transportation Command, the Defense Logistics Agency, the Air Mobility Command, the General Services Administration, and U.S. Army Materiel Command). Selected common user logistics support, to include limited multinational cooperation, is possible for some logistics functions, such as providing bulk fuel and water, class I, movement and movement control, port arrangements and operations, and sharing of facilities such as distribution and warehousing.[3]

As we try to bring some of these conceptual changes into reality, the military has taken steps to fix some of the issues and problems that have been experienced thus far. Some have resulted in procedural and materiel changes that have helped to enhance the JFC's ability to arrange operations and expand operational reach. These include:

1) In some Humanitarian Assistance support operations, Marine forces have used MPF ships anchored off the coast to supply water to the troops ashore via a flexible pipeline system. [4]

2) ROWPUs have been a hardened and tested water producer for the Services over the years. It can produce water from any type of water source (well, river, lake or stream), and turn it into purified water ready and drinkable. The major problem for most military logisticians is the ability to distribute water within the theater of operations. Distribution pipelines also make

[3] TRADOC Pamphlet 525-4-1, 34.

[4] Doug White, Lt Col, Stu Bracken, Major, and Greg Friend, LCDR, "Over the Shore Logistics: Delivering the Punch" (Norfolk, VA: Joint Forces Staff College, 2001): 9.

forces more vulnerable to conventional or IED attack. Distribution is believed to be tougher than the job of water production. Also, bottled water, as we have explained earlier, is more costly to purchase and transport.

This same type of problem set is what led Army Forces Command (FORSCOM) to search for creative solutions to support their forces with water in challenging operational environments such as the early years of force deployment to the Balkans in the mid-1990s. The solution they pursued was developed by the General Packaging and Equipment Company of Houston, Texas. Their solution consisted of a vertical form, fill, and seal machine that can package the water produced by ROWPUs in plastic bags. This system was tested in Hungary for over a year while conducting support operations for Operation Joint Endeavor (OJE). This initiative became the main source of potable water on the ISB in Taszar and Kaposvar, Hungary. The system was economically effective and very efficient to use. The major achievement of this initiative is that Soldiers slowly accepted the use of the bag water as compared to continually using bottled water.[5]

Statistics from OJE show that tens of millions of dollars were being spent on bottled water for soldiers in Hungary, Croatia, and Bosnia. This water came from commercial vendors in Italy and France at prices ranging from 30 to 70 cents per liter and shipped to Germershiem, Germany, and then on to locations in Hungary, Croatia, and Bosnia. The bottled water was then delivered by commercial trucks in leased containers. Truck delivery costs averaged from $1,000 to $4,000 per container, and the containers were leased at approximately $750 each. Analysis showed that bag water cost 30 cents per bag; it was transported by military vehicles within the area of operations, which eliminated the commercial transportation requirement. Overall the

[5] Jinoo V. Choi, Captain, US Army, "Bag Water for Operation Joint Endeavor," Army Logistician, http://www.almc.army.mil/alog/issues/Sep97/MS189.htm (accessed November 2010).

quality (taste, purity, met EPA standards) of the bag water was better than bottled water, costs were more economical, and it was suitable to military forces.[6]

3) The Defense Advanced Research and Projects Agency (DARPA), along with the U.S. Army Tank and Automotive, Research and Development Engineering Center (TARDEC) provided funding to MIOX Corporation provide a water disinfection unit for individual use. The product is currently sold at locations such as REI, Eddie Bauer, and Campmor. The military form of the product has the purifier in a desert brown or a green camouflage pattern. The MIOX Corporation technology for purifying and disinfecting non-saline water is a non-hazardous process that uses salt, water and electricity. The product uses a mixed oxidant solution that eliminates the objectionable taste and odor of the chlorine. It can treat any non-saline water source to produce safe, odorless water without a chlorine taste. This is a great tool to treat water at the point of consumption.[7]

4) The Air Force Special Operations Forces have an individual water purification device to meet their sustainment and survival water needs. It is a Nanomesh Filtration system technology that can remove enough arsenic content to make water safe to drink, producing approximately 1 liter every 8 minutes.

5) TARDEC is developing the Expeditionary Unit Water Purifier (EUWP). They are working with Village Marine Corporation on two prototype units, one that can produce 100,000 gallons per day and one that can produce 300,000 gallons per day from any water source. Each of these units would fit into one 20-foot long ISO container.

6) The U.S. Army Product Manager for Petroleum and Water Systems (PM PAWS) is developing a Rapid Installed Fluid Transfer System (RIFTS). This is a hose reel system that can

[6] Ibid.

[7] Army Science Board, *FY 2004 Task Force Report "Intra-Theater Logistics Distribution in the CENTCOM AOR* (Washington, DC: Department of the Army (ASAL&T), 2004): D-21.

lay down 20-30 miles of hose (fuel or water) in one day. One system can pump 800,000 to 1 million gallons per day. This system solves the labor problem associated with installing and recovering the Tactical Water Distribution System (TWDS), but it still doesn't solve the problem of safeguarding the pipeline after installation.[8]

7) U.S. Army TARDEC is also providing an Expeditionary Water Packaging System (EWPS) as a means to package drinking water in individual containers at a location near the point of consumption. Potable water will be supplied from either military water purification equipment (ROWPU or some sort of tactical water purification system) or from a commercial water purification system. The water packages will be bundled and palletized in various standard loads (tailored for specific unit sizes) for ease of movement to the point of consumption. This system gives great flexibility to the units providing support. It produces various size packages from 0.5 to 2 liters; bag production rate for 1.0 liter size is 2100 per hour; bottle production rate for 2.0 liter size is 700 per hour operating 6 days per week; and will meet the weight and size constraints of the C-130 aircraft and lift capable by the Heavy Expanded Mobility Tactical Truck-Load Handling System (HEMTT-LHS). It is also fully integrated (packaging equipment, environmental control unit, power generation, chlorination, and mineralization) and capable of self-sustained operations.[9] This system requires contractor support, but will reduce the number of convoys required to transport the water, which reduces the overall force protection requirements.

[8] JWRMAG #25, 5.
[9] Downing.

LOGISTICAL ADVANTAGES

	Expeditionary Water Packaging System	Local Procurement / Transportation
Operating costs		
Fuel		
Personnel		
Convoys		
Availability	Independent operation	Dependent on supplies
Logistics safety	No transport of bottles	Risk of attacks

Chart above: Logistical advantages of using the EWPS vice normal bottled water procurement.[10]

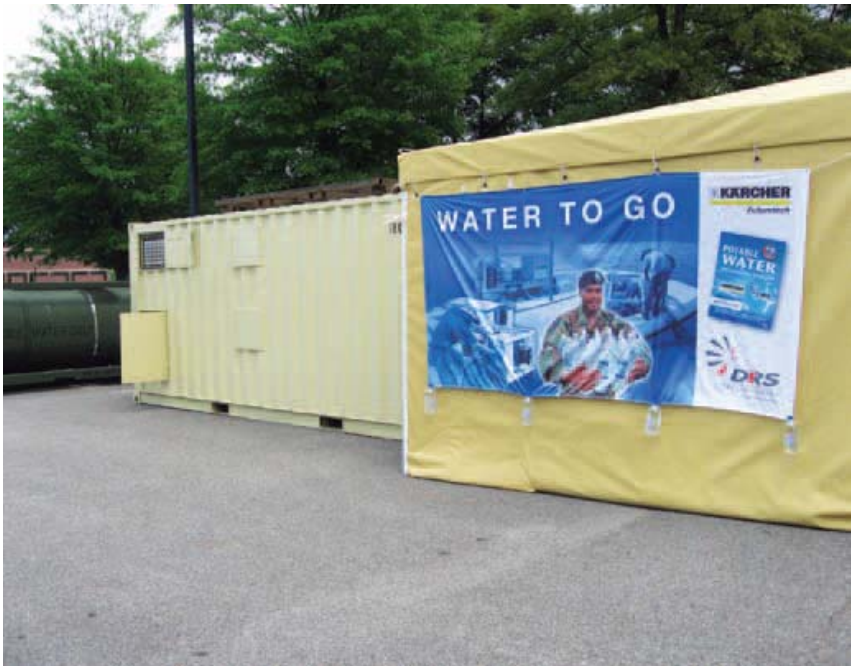

Photo above: EWPS set up for water purification operations.

8) Well drilling rigs and bottled water plants continue to be a potential solution. The capacity that comes from well drilling in an area of operation will allow access to water tables that can provide a large resource for producing potable water. It will still require the need to purify the

[10] DRS Technologies, *Expeditionary Water Packaging System (EWPS)* (St. Louis, MO: DRS Sustainment Systems, INC., 2007).

water through a ROWPU or bottled water purification system, but it will give additional capacity and capability to the theater commander.

In summary, these additional capabilities greatly enhance a commander's flexibility to exercise elements of operational design, especially operational reach and more alternatives for arranging operations.

Benefits to the Warfighter/Planner

The addition of the above systems to the military inventory broadens the capabilities that the Joint Force Commander has for water production and distribution within a theater of operations. In order to provide the full benefits to the Warfighter and logistics planners, we must eliminate the logistics issues concerned with water as experienced in our support to Somalia during the HA/DR mission conducted there by U.S. forces.

> Several nations shipped water to the coalition operation. Most countries provided water that was containerized in boxes. The bottled water arrived in plastic containers normally stored in cardboard boxes and stacked on pallets. Other plastic bottles of water arrived shrink wrapped in groups of 6-24 bottles depending on the size. The boxed water proved easy to stack, transfer, and issue. The shrink wrapped water could not be stacked because the lower layers would crush and water leaked from the containers. To add to the problems, the shrink wrapped pallets broke easily and were very difficult to handle with material-handling equipment. Soldiers issued the shrink wrapped bottles as soon as possible to alleviate wasted storage space. Along with the logisticians' shrink wrap problem, the situation deteriorated when a ship arrived at the port with over a million liter bottles of water. The bottles were containerized in cardboard boxes that became wet during the voyage to Somalia. Slowly, the weight of the top boxes caved in on the ones below and caused the total shipment to collapse. One piece, the 300,000 empty and 300,000 full liter bottles were hand loaded into a cargo net and transported to a truck for movement to the bottled water storage area. A large pump removed the 300,000 liters of water from the hull of the ship. This mishap occurred on three different ships. Only 50 percent of bottled water remained in before the UN logisticians modified the bottled water procurement process for containerization. Future operations may require bulk water from

> ROWPUs in direct support of food service, laundry, personal hygiene, and medical support. Packaged water may be used to facilitate distribution and individual consumption. Since boxed water was shipped and stored with less loss than shrinked wrapped bottled water, future coalition operations should consider designing resealable boxed water to supplement water purification units' water output.[11]

The above is a clear example of why we have to develop systems that produce and package water in useable forms that are tailored to support large amounts of forces or personnel when required. If we are unable to develop these systems then we have to rely on existing water purification systems and technology which has consistently done an outstanding job for the logistics community over the years. In addition, we must have the ability to distribute the water across large areas within our proven methods and concepts. This type of complexity is a direct hindrance to the commanders operational reach capability. Relying on the use of bottled water as an element of his support capability, and then having it tied up on ships is not the right answer. The JFC would like to project forces quickly and efficiently without delay to conduct their mission and inject their capabilities. The example above showed how the breakdown of bottled water tied up resources and support capability when it was needed the most and at the most crucial time. The example shows that limitations associated with providing a 100% bottled water solution and a critical vulnerability to a commander during mission execution.

Another action that could benefit JFCs and planners is established standards for water support when coming into a theater of operation. In a contingency operation, ROWPUs can be set up and established within the first 90 days or less; if needed some of the water requirements can be supplemented by bottled water. There should be no requirement for bottled water after the 6 month timeframe. The establishment of water wells, ROWPUs and treatment plants should

[11] Woody, 133-134.

be able to support water requirements further into the future. These are the standards that a JFC or CCDR should establish which ultimately will be a benefit to the Warfighter and their planners.

The overall benefit that these systems bring to the warfighters and planners is the capability to provide quality support in a resource constrained environment. Warfighters will be provided quality drinking water, while planners and commanders find ways to provide these services at a reduced cost, without degradation to the JFC's capability to extend his operational reach or to arrange operations in the most effective manner.

"Good logistics is combat power."

- Lieutenant General William G. Pagonis,
Director of Logistics during Gulf War of 1991

CHAPTER 4

CONCLUSION

"If the wars of this century were fought over oil, the wars of next century will be fought over water."

- World Bank Vice President Ismail Serageldin[1]

In conclusion, the U.S. military's reliance on bottled water in current military operations does hinder our ability to apply key elements of Operational Design, and thus limits options in support of our mission within all phases of the campaign. The thesis examined how the military's over reliance on bottled water has limited our ability to use other alternatives in future operations. Today and for the future, our military forces will have to consider the operational, resource, and logistics impact of continually using bottled water as a primary means of support when conducting military combat operations or humanitarian/disaster assistance support. The more resources and effort that is put into providing bottled water will inevitably lead to our forces, instead, to losing their capability, knowledge, and skill to purify water in support of operational requirements across the wide range of military contingencies. It will take military leadership, at the Service Component Chief or CCDR level, to enforce this change and mandate alternatives. Because of these alternatives and options available to the Joint Force Commander or logistical planner, support to operational forces during Phase 0 through Phase III, and the transition to Phase IV through Phase V of an operation will be executed successfully.

[1] Sam Bozzo , *Blue Gold, World Water Wars*, DVD, Directed by Sam Bozzo, Produced by Mark Achbar (2009).

Furthermore, the biggest issue as we move forward will be the continuing requirement to reduce the burden on resources and reduce costs associated with the support provided.

Additionally, this thesis reviewed how the large use of bottled water has impacted the JFC in various military campaigns. Impact to the JFC's campaign design is concentrated in two areas of operational design: operational reach and arranging operations. Reliance on bottled water will impact the commander's operational reach ability if planners do not look at ways to forward position capabilities and resources, thus increasing the range and effects of weapon and logistics systems and leveraging host nation support (HNS) and theater contracting support, while attempting to maximize the throughput efficiency of the water distribution architecture. The JFC must expand water support capability while constrained by costs, lift requirements, force protection requirements, and still be capable to provide water from the closest source. The military must be able to distribute the water administratively and tactically to military personnel or civilians. These objectives would be an overall improvement in the eyes of planners and commanders working towards a successful operation. The other challenge, arranging operations, enables the military to ensure that we arrange and employ the right force structure with the proper capabilities before going into an operation. This arrangement of capabilities allows the JFC to determine the best tempo of activities in time, space, and purpose. With water available from a variety of means, to include nearby sources, JFCs and planners will have better flexibility to move forces with the required capability in order to synchronize their deployment in the right arrangement. The military goal must focus on ensuring that we do not over rely on bottled water to a point that will impact the JFC's operational reach or arranging operations.[2]

Water is critical to the support provided to and by U.S. military forces. Currently, expenditures for bottled water are considerable when compared to utilizing ROWPUs or other

[2] JP 5-0, Joint Operational Planning, III-37 - III-38.

water purification capabilities. All services have the capability to provide water purification once they have been set in a fixed location with available assets and resources. The requirement to go to a strictly bottled water established operation is no longer feasible, acceptable, or suitable, unless it is dictated for a short duration operation. With tightened service budgets, commanders and planners must enforce the use of reverse osmosis to provide water to those requiring support. ROWPU produced water has been proven to be more cost effective than bottled water. In accordance with Dr. Strange's theory, bottled water may be considered a critical requirement to some personnel, but a critical vulnerability to the service budgets.

Further, water is a critical vulnerability when it comes to the U.S. military and its ability to produce and protect this commodity. The military must continue to plan for force protection of our water capability and movement of water resupply across the operational space. This level of planning and methodical look into force protection requirements will attempt to ensure that our support lines of communication are not interrupted, and that lives are saved.

United States military leadership must always maintain the perspective that the military is a representation of American society. U.S. military forces will bring the tendencies and biases with them as associated to water, just as anyone in the American population in general. Our forces will bring with them the desire for bottled water because of taste and comfort. Military leaders must assess whether the need for taste and comfort outweigh the need to have safe drinking water at a reduced cost, reduced force protection requirements, and with an efficient distribution system. This assessment can lead to benefits for our warfighters. There will be the need for policy changes, such as enforcement of the use of ROWPUs and establishment of water sources closer to the point of use. Policy makers and leaders will be charged to set and enforce standards and regulations that will limit the use of bottled water after the first 90 days of an

operation. Considerable economic savings and force support benefits to the JFC and planner would result from these efforts.

The military's movement through the 21st century will be predicated with reduced force structure, reduced budgets, and reduced forward presence in numerous locations throughout the world. Joint planners will have to figure out the best methods to provide humanitarian assistance and disaster relief support, along with conducting normal support operations, all on a limited budget. Bottled water may not seem to the common person as an economic high end commodity, but when the numbers are calculated it has been shown to be a very expensive support requirement. No longer will the open valve of bottled water be an immediate consideration without the immediate thought of how we pay the bill.

Lastly, before planners make final decisions about the use of bulk or bottled water, they should review some planning considerations: comparison of total ROWPU cost-production data (personnel costs, reserve call up requirements, a need for more bulk field-distribution equipment, and force protection costs) to contract bottled water costs to ensure an accurate comparison. The decision to rely primarily on one water source over another may vary, depending on the campaign. In the end, "…the selection of the best means to supply water is a hard decision which must balance multiple objectives (e.g., security, palatability, and convenience) against limited resources (e.g., cost, airlift, trucks, and personnel)."[3] The military's goals in support of our forces must be high water quality with better taste, while maintaining our flexibility and capability. We must also be able to reduce force protection requirements, transport requirements, acquisition costs, packaging requirements, and implement a recycling capability.

[3] Brian S. Hughes, Capt, US Air Force, "Evaluating Alternatives for Drinking Water at Deployed Locations" (masters thesis, Air Force Institute of Technology, Air University, 2006): iv.

This will occur while maintaining flexibility and adaptability to apply key elements of operational design.

In summary, the U.S. military's reliance on bottled water in military operations does hinder our ability to apply key elements of Operational Design, and thus limits options in support of our mission within all phases of the campaign. Commanders and planners must continue to develop ways to support operational forces during Phase 0 through Phase III, and the transition to Phase IV through Phase V of an operation. In addition, they must continue to analyze the amount of resources and costs that are involved, and understand that bottled water doesn't have to be the only option. The use of ROWPU water can compliment or become the primary source of supply. As LtGen Panter clarified during his discussion of operational reach during Operation Unified Assistance, military forces must maximize their use of arranging the right force structure, at the right time, to effectively complete the mission. [4] This attention to logistical detail leads to effective use of the operational elements of operational reach and arranging operations, and ultimately to successful campaign design and mission accomplishment.

"Amateurs think about tactics, but professionals think about logistics."
- General Robert H. Barrow, USMC
(Commandant of the Marine Corps) noted in 1980

[4] Guest Speaker, "Case Study of Multinational Planning and Operations in Support of CSF-536" (lecture, Norfolk, VA: Joint Forces Staff College, March 15, 2011).

ACRONYMS

AOR	AREA OF RESPONSIBILITY
ASCC	ARMY SERVICE COMPONENT COMMAND
BPA	BLANKET PURCHASE AGREEMENT
CC	CRITICAL CAPABILITIES
CCDR	COMBATANT COMMANDER
CCMD	COMBATANT COMMAND
CFLCC	COMBINED FORCES LAND COMPONENT COMMANDER
COG	CENTER OF GRAVITY
CONPLAN	CONTINGENCY PLAN
CR	CRITICAL REQUIREMENT
CSC	CONVOY SUPPORT CENTER
CSSB	COMBAT SERVICE SUPPORT BATTALION
CV	CRITICAL VULNERABILITY
DARPA	DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
DOS	DAYS OF SUPPLY
DOTMLP-P	DOCTRINE, ORGANIZATION, TRAINING, MATERIEL, LEADERSHIP, PERSONNEL, AND POLICY
EWPS	EXPEDITIONARY WATER PACKAGING SYSTEM
FOB	FORWARD OPERATING BASE
FORSCOM	U.S. ARMY FORCES COMMAND
FY	FISCAL YEAR
GLOC	GROUND LINES OF COMMUNICATION

GPE	GENERAL PACKAGING AND EQUIPMENT
GPH	GALLON PER HOUR
HA/DR	HUMANITARIAN ASSISTANCE/DISASTER RELIEF
HEMTT-LHS	HEAVY EXPANDED MOBILITY TACTICAL TRUCK-LOAD HANDLING SYSTEM
HNS	HOST NATION SUPPORT
ISB	INTERMEDIATE STAGING BASE
ISSA	INTER-SERVICE SUPPORT AGREEMENT
JAWS	JOINT ADVANCED WARFIGHTING SCHOOL
JCA	JOINT CAPABILITY AREA
JFC	JOINT FORCE COMMANDER
JTF	JOINT TASK FORCE
KBR	KELLOGG, BROWN, AND ROOT
MEAT	MARINE CORPS ENERGY ASSESSMENT TEAM
MPF	MARINE PREPOSITIONED FORCES
MNF-I	MULTI-NATIONAL FORCES-IRAQ
MOS	MILITARY OCCUPATIONAL SPECIALTY
MSR	MAIN SUPPLY ROUTE
NCO	NON-COMMISSIONED OFFICER
OEF	OPERATION ENDURING FREEDOM
OIF	OPERATION IRAQI FREEDOM
OJE	OPERATION JOINT ENDEAVOR
OPLAN	OPERATIONS PLAN
PM-PAWS	PETROLEUM AND WATER SYSTEMS

RDJTF	RAPID DEPLOYMENT JOINT TASK FORCE
RIFTS	RAPID INSTALLED FLUID TRANSFER SYSTEM
ROWPU	REVERSE OSMOSIS WATER PURIFICATION UNIT
RSO&I	RECEPTION, STAGING, ONWARD MOVEMENT, AND INTEGRATION
SECDEF	SECRETARY OF DEFENSE
SMFTS	SEMI-TRAILER MOUNTED FABRIC TANKS
TACOM	U.S. ARMY TANK AND AUTOMOTIVE COMMAND
TARDEC	U.S. ARMY TANK AND AUTOMOTIVE, RESEARCH AND DEVELOPMENT ENGINEERING CENTER
TB	TECHNICAL BULLETIN
TCP	THEATER CAMPAIGN PLAN
TPFDD	TIME PHASED FORCE DEPLOYMENT DATA
TRADOC	U.S. ARMY TRAINING AND DOCTRINE COMMAND
TRANSCOM	UNITED STATES TRANSPORTATION COMMAND
TSC	THEATER SUSTAINMENT COMMAND
TWDS	TACTICAL WATER DISTRIBUTION SYSTEM
UBL	UNIT BASIC LOAD

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VITA

Lieutenant Colonel (P) Moore is a native of Philadelphia, Pennsylvania. He is a Distinguished Military Graduate of the Virginia State University ROTC Program and was commissioned in May 1989. He graduated Cum Laude with a Bachelor of Science Degree in Business Information Systems, and also holds a Masters Degree in Public Administration from Troy State University.

Lieutenant Colonel Moore is currently assigned as a student in the Joint Advanced Warfighting School (JAWS), Joint Forces Staff College, Norfolk, Virginia. His previous assignments included: Quartermaster Branch Chief for the Enlisted Personnel Management Directorate, Army Human Resources Command, Alexandria, Virginia; Commander, 1st Battalion, 402nd Army Field Support Brigade, Iraq; Executive Officer to the Director J9, also Operations Officer for the J9 Integration Group, and Logistics Action Officer in the Joint Deployment Process Office (JDPO), U.S. Joint Forces Command (JFCOM); Executive Officer to Director, Concept Development and Experimentation, and as a Logistics Action Officer, Capabilities Development Directorate, Army Capabilities Integration Center (ARCIC), TRADOC, Fort Monroe, Virginia; Battalion Executive Officer and Support Operations Officer, 203rd Forward Support Battalion, 3d Brigade Combat Team (3BCT), 3d Infantry Division, Fort Benning, Georgia (OIF I); Executive Officer to the Director of Plans, Operations, and Logistics Automation Directorate, and Action Officer/Briefer Logistics Operations Center (LOC), HQDA G4, Pentagon, Washington, DC; Defense Logistics Agency (DLA)/Army Quartermaster Internship Training Program at Fort Belvoir, Virginia; Commander, 542d Maintenance Co, 44th Corps Support Battalion (CSB), 593d Corps Support Group (CSG), Chief Supply and Services

Branch, Support Operations Section, 44th CSB, Chief General Materiel Branch and Class IX Officer, 20th Support Center (CMMC), Fort Lewis, Washington; and Platoon Leader and Plans and Operations Officer, 22d Area Support Group, Vicenza, Italy. Following graduation from JAWS, Lieutenant Colonel Moore will be assigned to NATO Allied Command Transformation, Norfolk, VA as the Logistics Branch Head for Joint Deployment and Sustainment.

Lieutenant Colonel Moore's military education includes the Joint Forces Staff College – Joint Advanced Warfighting School (JAWS), Joint and Combined Warfighting School (JPME) Phase II course, Command and General Staff College (CGSC), Joint Course on Logistics, Combined Arms and Services Staff School (CAS3), Support Operations Course, Combat Developers Course, Subsistence Officers Course, Contracting Officer Representative Course, Supply Support Activity Management Course, and the Quartermaster Officers Basic and Advanced Course. This thesis is part of the Joint Advanced Warfighting School's Masters of Science degree in Joint Campaign Planning and Strategy.